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IN THEIR APPLICATION TO

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THE CHEMICAL NEWS,

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THE CONSTITUTION OF THE OXIDATION PRODUCTS OBTAINED BY THE ACTION OF CHROMYL CHLORIDE ON THE TERPENES, AS DEDUCED FROM A NEW INTERPRETATION OF THE REACTION.

By JAMES SWORD, M.A., B.Sc., Ph.D., A.I.C.

The University of Glasgow.

The investigation of the action of chromyl chloride on the terpenes showed that the progress of the action was similar to that recorded by Etard and his co-workers for the hydrocarbons of the benzene class[1]. His results may be summarised as follows : most hydrocarbons combine with chromyl chloride to give additive compounds, containing $2CrO_2Cl_2$ per molecule of the hydrocarbon. These compounds are brown amorphous solids which rapidly decompose in contact with moisture, and, on heating, liberate in succession two molecules of HCl. The oxidation products are obtained on addition of water to the compound.

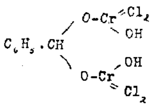
In conclusion he enunciated the general rule that two molecules of chromyl chloride are attached to the hydrocarbon by the displacement of two hydrogens from the methyl group, and in preference from the methyl group which is attached to the carbon atom with the most hydrogens, thus :—

$$C_xH_y.CH_3 + 2CrO_2Cl_2 = C_xH_y.CH(O.Cr(OH)Cl_2)_2$$

Here it must be observed that Etard used the formula

$$\begin{matrix} O \\ | \\ O \end{matrix} >Cr : Cl_2$$

instead of that adopted in recent years containing hexavalent chromium, but it is possible that the older formula is nearer the truth, for it at once distinguishes the oxygen through which salts are formed, which the more recent formula does not, and while the latter is based on analogy with the accepted formula for sulphur trioxide, in which sulphur is hexavalent, there is, on the other hand, the equally good analogy, which Etard makes between the additive compound



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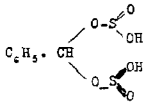


in which sulphur is quadrivalent.

The mechanism involved in the production of quinone from benzene, nitro-quinone from nitro-benzene, etc., need not be discussed, as later experimenters completely failed to obtain any evidence of this reaction with pure materials[2]. In special cases, however, a somewhat analogous reaction does take place, one of the oxidation products being a di-ketone. Thus, phenanthrene was found to yield phenthraquinone, and stilbene yielded benzil[12]. This type of reaction, however, is clearly outside the limits of Etard's conception, and will be considered later. When applied to the terpenes his hypothesis must be admitted to be quite inadequate to explain the products obtained.

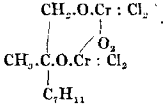
Thus, applying his rule to limonene, which contains two methyl groups, there should result from the action of chromyl chloride on that hydrocarbon the two aldehydes $\Delta^{1:8}$-p-menthadiene-10.al. and $\Delta^{1:8}$-p-menthadiene-7.al. Neither was obtained in the products which consisted of the well-known p.tolyl-methyl-ketone and α.p.tolyl-propaldehyde[3, 4]. These were again the products obtained from terpinene[4], which, from Etard's rule, should have yielded $\Delta^{1:3}$-p-menthadiene-10.al., and $\Delta^{1:3}$-p-menthadiene-7.al., but which were not found. His hypothesis was no more successful when used to predict or explain the products from sabinene[5], camphene[6], bornylene[7], α.pinene[8], and β.pinene[9]. It does not follow that his conceptions were

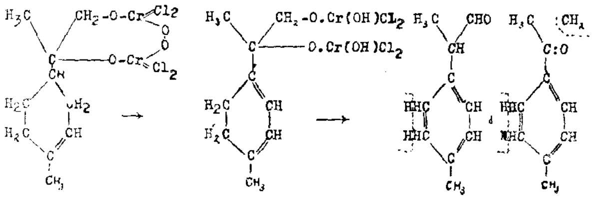
rrong in principle although quite inade-
juate, and indeed the following interpreta-
ion may be regarded as a liberal extension,
ather than as a contradiction of his
onclusions.

Taking limonene as a type of monocyclic
erpene, the formation of α.p.tolyl-propal-
lehyde and p.tolyl-methyl-ketone shows that both methyl groups have escaped attack, and that if the methylene is attacked, it is not after the manner in which Etard suggested. On the other hand, if it be assumed that the addition of chromyl chloride takes place at the double bond, both molecules being attached through an oxygen, there is an almost equal chance of the oxidation taking place at '8' carbon as at '10' carbon (using the scheme

$$7—1<\begin{matrix}2—3\\6—5\end{matrix}>4—8<\begin{matrix}9\\10\end{matrix}).$$

The uniformity with which the reagent reacts in double molecule to give the additive compound indicates a closer connection between the molecules than Etard imagined, and it is probable that the additive compound is more correctly represented by the formula





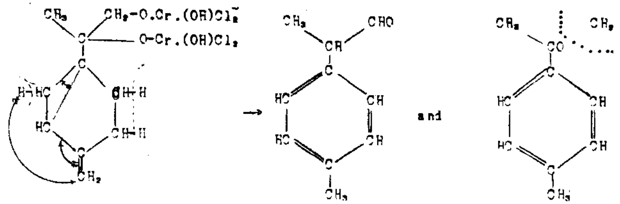
It is quite possible that, when the structure of the molecule favours the change, this compound takes the form he suggested, for the persistent appearance of the cymene structure in the products from the monocyclic terpenes, and even from the dicyclic sabinene, indicates that this reagent facilitates internal rearrangement in the molecule, which, of course, would tend towards the formation of the most stable form; the dissociation of two hydrogen atoms might then take place and account for the formation of a new double bond as in the formation of α.p.tolyl-propaldehyde from α.terpinene. These 'new' double bonds could, of course, be entirely explained by simple oxidation in the form of dehydrogenation.

The following mechanism would appear to satisfy these considerations and suggests a reasonable explanation of the products obtained.

The formation of α.p.tolyl.propaldehyde from cymene[11] could be explained in the same way as the formation of benzaldehyde from toluene, but the formation of the accompanying p.tolyl-methyl-ketone is left without explanation. If, however, the mechanism proposed for limonene is correct, it is reasonable to suppose that the two molecules of chromyl chloride are not both attached to the same carbon ('10'), but that the second molecule is attached to the adjacent '8' carbon. The decomposition of the compound would then give both the products named, as in the case of limonene.

To explain the formation of these two substances from α.terpinene, the same process has only to be followed, the addition taking place at '8' and '10' carbons and two hydrogens being oxidised off from '2' and '3.'

The formation of α.p.tolyl-propaldehyde from sabinene must take place somewhat after the following manner :—



The main products, however, do not revert to the cymene structure but are again the result of an addition at the double bond. Assuming the decomposition to proceed as explained in the case of limonene, the products expected would be 1.isopropyl-4, methylal-bicyclo [0.1.3].-hexan - and 1.isopropyl-bicyclo [0.1.3]-hexanone, 4.

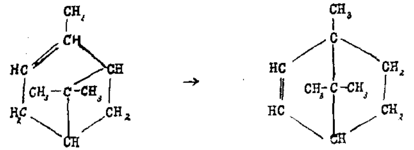
The first has not been described elsewhere and it may be assumed provisionally that it represents the aldehyde $C_{10}H_{16}O$ which was obtained. The ketone $C_9H_{14}O$, which was obtained, was identified as Δ^1 1-isopropyl cyclohexenone, but Wallach has shown[10] that, on treatment with dilute acid sabinaketone, *i.e.* 1.isopropyl-bicyclo [0.1.3]-hexanone, 4., is changed into the two isomers Δ^1 -1.isopropyl-cyclohexene-4. one and Δ^2 - 1.isopropyl-cyclohexene-4. one.

That the second isomer was not isolated is in no way remarkable when it is remembered that the products are always contaminated with a large quantity of resin and are only separable with extreme difficulty.

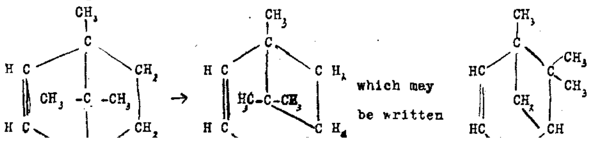
Applying the suggested principles to camphene, the two products expected would be camphenilanaldehyde, *i.e.*, 2.2. dimethyl-3.methylal-bicyclo [1.2.2.]-heptan and 2.2.dimethyl-bicyclo [1.2.2.]-heptan-3. one. The former is recorded as the sole primary product.

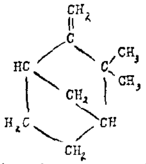
From bornylene two isomeric ketones would be predicted, namely, 1.7.7. trimethyl--bicyclo [1.2.2.]-heptan-3. one, and 1.7.7. trimethyl-bicyclo [1.2.2.]-heptan-2 one.

The only product recorded is again camphenilanaldehyde. This is remarkable, for its formation necessitates a very considerable internal rearrangement of the bornylene molecule. The change recalls the action of acid on α.pinene :—

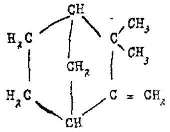


The transformation which occurs during the addition of chromyl chloride must take place in a manner somewhat as follows :—





which may be written



With the possibility of such extensive rearrangement of structure, it would not be surprising to find that the products from the action of chromyl chloride on the pinenes had no relation to those expected, as they might indeed have no relation to the parent hydrocarbons. That the products predicted by the preceding hypothesis agree, at least in their empirical formulæ, with those of the products actually obtained, adds considerable support to the theory.

The absence of a double bond outside the ring in α.pinene suggests that the methyl group would be attacked as in toluene. The absence of *α.p*-tolyl.propaldehyde in the oxidation products recorded, indicates that the bridge is not the point of addition, for, the consequent rupture of the bridge would have established the cymene influence.

These considerations suggest the possibility of three products :—

Pinocamphone, $C_{10}H_{16}O$ *i.e.*, 2 .7.7. trimethyl-bicyclo-[1.1.3.]-heptan-3 one;

Nopinone, $C_9H_{14}O$, *i.e.*, 7.7. dimethyl-bicyclo [1.1.3.]-heptan-2, one;

Myrtenal, $C_{10}H_{14}O$, *i.e.*, Δ^2 -7.7. dimethyl-2.methylal-bicyclo [1.1.3]-heptene.

In the same way the primary products from *β*-pinene would be predicted as nopinone and 7.7. dimethyl-2.methylal-bicyclo-[1.1.3]-heptan.

The empirical formulæ of these agree with those recorded [8, 9]. Complete identity could not be established from the data, but the difficulty of obtaining the products in a really pure condition is evident in the papers, which may possibly explain why the ketone obtained from both *α*- and *β*-pinene did not have the boiling point of pinocamphone but yielded a semicarbazone which had the melting point of that substance. This would also explain why the nitrogen content was consistently low for the semicarbazone of $C_9H_{14}O$. The aldehyde $C_{10}H_{16}O$ from α-pinene, remains unexplained on the suggested hypothesis, but it would appear to be impossible to explain it as a primary product, for its formula demands that it be produced by oxidation at the double bond, and only ketones could result from such a process.

If the hypothesis be tested by an application to substances outside the terpene group, the work of Henderson and Gray on phenanthrene, stilbene and styrene[12], entirely confirm the suggested hypothesis, only one further extension, and that an altogether probable one, being required, that in substances which have a balanced structure about a double bond, oxidation takes place to some extent at both ends of the double bond to give a diketone (phenanthraquinone and benzil). With this extension, prediction and experiment are in complete agreement.

Conclusion.

The action of chromyl chloride on hydrocarbons must be considered as essentially one of addition of $2CrO_2Cl_2$ at a double bond. The peculiar nature of the reagent, however, appears to make it capable of displacing and combining with an atom of hydrogen from each of two adjacent carbons, and in extreme cases (*e.g.*, toluene), from a single methyl group.

Decomposition of the additive compound yields aldehydes and ketones according to circumstances, a side chain being oxidised off, on occasion, to give the ketone.

When the double bond divides the molecule symmetrically (*e.g.*, phenanthrene), at least one of the products will be a diketone.

The addition of the dual molecule of chromyl chloride appears to render the molecule particularly liable to a rearrangement of configuration (bornylene to camphene structure), which reduces the value of the reagent for the investigation of constitution.

A double bond in a side chain is attacked before one in the nucleus (limonene), and a benzene nucleus last of all.

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BRITISH ASSOCIATION—SECTION B.

DISCUSSION ON THE ALTERNATING EFFECTS IN CARBON CHAINS.

September 1st, 1925.

(*Summary of the Positions taken up by the Different Participants in the Discussion.*)

PROFESSOR A. LAPWORTH.

The term " polarity theory " is a wide one, covering many views and may not arbitrarily be restricted to those which are expressed in terms of electronic valency conceptions. His own views were based on and regulated by his hypothesis of 1901, which postulated alternate effects, recognised by chemists even before that date, and was in fact originally devised to explain alternate effects. The hypothesis assumed that many organic chemical reactions proceed by formation and decomposition of complex ions, broadly on the lines of the theory of Abegg and Bodländer. The types considered in 1901 were the simple ones

$$A + \overset{(+)}{B} \longleftrightarrow \overset{(+)}{AB}$$

and

$$C + \overset{(-)}{D} \longleftrightarrow \overset{(-)}{CD}$$

each to be read in either direction; anc recent developments indicate that at leas one more type should be recognised namely,

$$A + B \longleftrightarrow \overset{(-)}{A} - \overset{(+)}{B}$$

the superimposed signs denoting electrica changes, localised or diffuse, as the cas may be.

If the new complexes to be produce belong to a type which is " stable "—tha is, associated with a low free energy or hig entropy—then the reactions are likel *ceteris paribus*, to be the more readil formed. The usefulness of the hypothesi depends largely on a previous knowledge o what are " stable " forms in the sens indicated, but many types are quite wel known and easily recognised. For example many anions of the general form R—O—(typified by the anions of water, alcohols phenols and carboxylic acids, are we known to be water-stable, the stabilit *varying with the composition and structu* of R. As an illustration of this idea it wa *suggested* (1901) that *acetanecyanohydri* is formed as follows :—

$$CN - \ominus + CMe_2 = O \longleftrightarrow CN.CMe_2 - O - \ominus$$

which leads at one step to a form of reco nisably " stable " type, and it was afte wards proved that such ions actually exi in aqueous solutions of ketone- and ald hydecyanohydrins, some being so stab that the crystalline pottassium salts ca be obtained from aqueous solutions. Th *corresponding form of the complex io* from, say, crotonaldehyde, would arise a *follows :—*

$$CN - \ominus + CH_2 = CH - CH = O \longleftrightarrow CN - CH_2 - CH = CH - O - \ominus$$

and as such an event can only take pla (in this simple mode) at the first and thi carbon atoms in the three-carbon comple the alternate effect was, in a sens accounted for

The application of the same principle to the case of the union of an aromatic amine at the para position with a positively charged ion, such as a diazonium ion, had been referred to by Professor Lowry; it was one which the speaker had entirely overlooked until Professor Robinson entered the field.

The extension of the complex ion hypothesis to the addition reactions of ethylenic and aromatic hydrocarbons is much more speculative, but the possibility at least suggests new lines of experimental enquiry.

Formulæ containing free polar partial valencies or free polar affinities are doubtless speculative, but as electrovalence is the only kind of externally directed attractive force between *molecules* which has been recognised, formulæ with free non-polar affinities are more speculative still. The speaker had used them with the polar sense only in so far as they seemed to run parallel with the requirements of otherwise sound chemical theory; but he was beginning to believe that they often had a mere mnemonical significance.

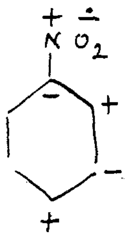
The question, " From where is the necessary energy required to produce polar activated forms supposed to come? " had various answers. In cases where activation is due to induction from, or association with, pre-existing polar molecules (as assumed in some cases by Thomson), then the answer was not quite the same as when activation is what may be termed " automatic," or better, perhaps, " purely thermal." The speaker had found that this latter case, really the simplest of all, was still widely misapprehended, and he therefore thought it worth while to paraphrase very briefly a fundamental well-known principle. The most stable homogenous systems are not those which contain all their molecules in the most stable forms ;for example, if a gas molecule is capable of existing in two forms then at complete thermal equilibrium, the gas, in the absence of any absorption of radiant energy, will in general contain both types of molecules in the ratio K (the familiar Mass-law constant) and K may be calculated from the relation :

$$F = RT \log_e K$$

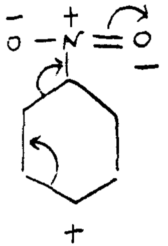
where F is the amount of work required to convert a gram molecule of the more stable form of the gas into the less stable form without change in volume or temperature. The energy, if any, required for the conversion of the one form into the equilibrium quantity of the other form, comes from the same source as that required for any endothermic reaction, namely, from the heat of the surroundings if the reaction is adiabatic. These are points which broadly do not admit of dispute except in slight academic details. It may be contended that F for activation is so large that K is negligably small, but that is an objection which can be tested in any given case when the value or even the order of magnitude of F has been discovered.

Professor R. Robinson.

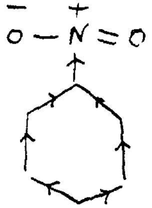
It has been stated by Flürscheim that it is not possible to construct a hydrogen molecule with shared electrons without conflicting with the Rutherford-Bohr-Sommerfeld theory of the atom. The mathematical difficulties may be great indeed, but it is unnecessary to regard them as insuperable, especially in view of the fact that Bohr's theory already includes postulates which are foreign to classical dynamics. When Copernicus constructed his system he might well have been met with the criticism, analogous to Dr. Flürscheim's present argument, that all the mathematical problems of the solar system had not yet been solved. The theory of shared electrons supplies a convincingly simple explanation of a large number of numerical coincidences, and it is unquestionably a useful working hypothesis. In the speaker's view, the charges, small or large, of ions or polarised complexes, merely function in facilitating a reaction by bringing the parts into contact. The process of chemical change which then occurs will include the reduction of the external fields, but will by no means be confined to this. In agreement with Lapworth, an alternating polar effect, represented occasionally by symbols such as $\overset{+}{A}\,\overset{-}{B}\,\overset{+}{C}\,\overset{-}{D}\,\overset{+}{E}$, is not taken to mean the simultaneous exhibition of all the charges represented. These symbols are mnemonics combining in one expression all the possible polarised forms of the molecule. In view of the development of the underlying electronic theory the use of such symbols may well give place to that of arrows showing the direction of displacement of electrons due to the general electrical effect or to conjugation. In nitrobenzene, for example, we have :—



(A) *Sign-labelling from Key atom.*



(B) *Conjugation of* NO_2 *with nucleus.*

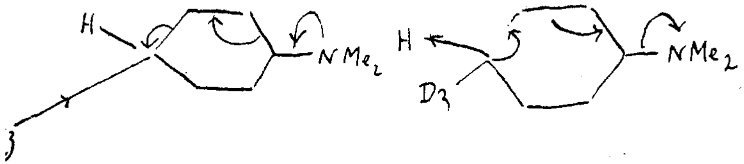


(C) *General Electrical Effect.*

The process (B) inhibits o-p substitution and (C) inhibits p-substitution and assists o- and m- substitution. The − signs in (A) seen in the light of the particular explanation (B) could well be omitted, although it is not necessary to do so since + and − are symbols having a significance relative to some standard only.

Much has been said about "point addition," and this has been contrasted with addition to a conjugated system. The speaker considered that this contrast is misleading and unnecessary. In the many cases where point addition of an ion occurs an electrical charge appears at some other point. Thus in the case of dimethylaniline, there is an electron flow towards the p-position and the reaction with a diazonium salt consists in the addition of the diazonium ion to the p-position and of a positive charge to the nitrogen atom. Neutralisation of the latter synchronises with loosening of the p-hydrogen atom and the completion of the reaction may be due to oscillations of the electrons in the system, each of which produces a very small charge on the nitrogen atom. Every surge of electrons from the nitrogen atom enables the carbon atom in the p-position to tighten its grip on the diazonium ion and every return to the normal similarly allows the proton in the p-position to escape from the molecule.

(*To be Continued.*)



ON THE TERNARY DIAGRAM OF THE SYSTEM IRON, CARBON AND COPPER.

By Torajirz Ishiwara, Takeo Yonekura and Toyozo Ishigaki.

(*Science Papers of Tôhoku Imperial University, Sendai.*)

INTRODUCTION.

The investigation of the effect of copper on the physical properties of steel is a matter of great importance for the metallurgy of iron in our country; because in this country iron ores almost always contain a small amount of copper. According to the previous results, when the copper content exceeds some 5 per cent., the steel is red short and difficult to forge; if, however, copper content is lower than this amount the steel can be either rolled or forged. As regards the properties, at ordinary temperatures of steels containing copper, it is known that hardness and strength as well as their resistance to chemicals are promoted by the addition of this element.

This advantage effect of copper on steel is similar to that produced by nickel or chromium and for this reason the investigation of copper steel has been carried out by many metallurgists such as Stead, Brenil, Shirotani, and others.

SUMMARY.

1. Theoretical: The equilibrium diagrams for the systems cementite-copper and iron-cementite-copper have been considered; especially in the latter case, the following equilbria have been dealt with :—

(i) Peritectic equilibrium of pseudo-binary form.

(ii) Invariant equilibrium consisting of two liquid and two solid phases.

(iii) Ternary peritectic equilibrium.

(iv) Ternary eutectoid.

2. Experimental: The portion of the ternary diagram representing the state of the alloys containing less than 30 per cent. of copper has been determined.

Microscopic: The binary and the ternary eutectoid structures were determined.

NATURAL IONIZATION IN GASES

By James W. Broxon.

(*The Physical Review, U.S.A.*)

ABSTRACT.

Measurements of the *pressure variation* of the natural ionization in air, nitrogen, oxygen and carbon dioxide contained in a steel sphere of one foot inside diameter, made by H. F. Fruth for pressures from 1 to 75 atmospheres, were repeated with slight modifications. Results obtained corresponded with those of Fruth with the following exceptions: (1) although the pressure rate of variation of the natnral ionisation at high pressures was very small (0.4 to 1.0 ion/cc sec. atm.) no abrupt change in the rate of variation and no true "saturation" value of the ionization were observed; (2) no "anomalous" behaviour was noted in the case of commencial nitrogen. Measurements to detect the *variation with size of chamber* were carried out with spherical iron ionization chambers of 7, 9, and 12in. respective internal diameters. The rate of production of ions per cc at high pressures did not vary unidirectionally with the size of the ionization chambers, but was least in the 9in. sphere. To study the *effect of the lining* the experiments were repeated with oxygen in each of the spheres lined with aluminium of 1/16in. thickness, and in the 12in. sphere lined with copper of 1/16in. thickness. The aluminium lining increased the ionization at low pressures, and decreased its pressure rate of variation at high pressures. The *effect of water vapour* on the natural ionization in aged, dust-free air, or upon its variation with pressure was found to be negligible. Both the absolute and the fractional *variation of the natural ionization with time* were found to depend upon the pressure, the average value of the former during a 24 hour period being about twice and that of the latter being about 1/5 as great in oxygen at 5.4 atm. pressure as in air at atmospheric pressure. Very slight evidence of a singly periodic diurnal variation in air at atmospheric pressure was observed. Attempts to determine the *effects of slow chemical reactions* upon the natural ionization in air and oxygen at atmospheric pressure led to negative results.

General Notes.

CANADIAN PRODUCTION OF ASBESTOS IN 1925 EXCEEDS ALL PREVIOUS RECORDS.

A new high record was established in 1925. Total shipments for the year were 290,389 short tons, valued at $8,988,360, as compared with 225,744 tons at $6,710,830 in 1924.

Exports of asbestos (including sand and

waste) in 1925, totalled 258,017 tons, or 53,268 tons in excess of the quantity of the quantity exported in 1924. Shipments to Great Britain amounted to 8,709 tons, to United States 209,879 tons, and to Germany 11,120 tons. Exports of asbestos to Australia, Belgium, France, Italy and the Netherlands increased materially.

In the asbestos mining industry in Canada during 1925 the amount of capital employed by the fourteen producing firms was $38,138,046. Employment was furnished 117 salaried employees, 1,315 mine workers and 1,150 mill workers and their combined earnings amounted to $,997,107. A ten-hour day was usual throughout most of the field. Fuel and electricity cost $923,239, including $546,175 for 60,508,285 kilowatt hours of electricity. Plant equipment included 406 electric motors having a combined rating of 28,621 h.p.

Six plants in Canada manufacture asbestos products, including the following commodities: asbestos paper and mill board; asbestos roofing of all kinds ;asbestos rigil shingles; asbestos building materials; asbestos cellular and sponge-felted pipe insulation; insulating sheets and blocks; asbestos brake linings and clutch facings (woven on special looms); and asbestos packings for steam, oil and hydraulic operations.

PROCEEDINGS AND NOTICES OF *SOCIETIES.*

THE ROYAL SOCIETY.

Papers read on Thursday, June 24, 1926.

On the Structure of the Arc Spectrum of Gold. By J. C. McLENNAN, F.R.S., AND A. B. McLAY.

We have been able to classify by our term scheme nearly all the wave-lengths known to belong to the gold arc-spectrum. The most important wave-lengths not yet classified are six, given in a table, that were found to be absorbed by the vapour in the under-water spark of gold. These wave-lengths undoubtedly involve the metastable term $1D_3^2$ and will probably be found to lead to the indentification of certain of the terms of the group $F^2D^2P^2$ with the limit D^1 in the table, 2b, or to certain of those of the groups in the table, 2c. But we have not any further evidence in support of this view. Zeeman-effect experiments will probably furnish the best means of definitely settling this question and any other features of the arc-spectrum of gold not yet clear.

On the Series Spectra of Palladium. By J. C. McLENNAN, F.R.S., AND H. G. SMITH.

The regular arc-spectrum of palladium, involving disturbances of a single electron outside a core of nine 4_3 electrons, includes very nearly all the strong lines of the arc, and most of the faint lines of wave-length longer than 3400 A. In the region of shorter wave-lengths there are also a large number of faint lines, apparently belonging to the arc-spectrum, for which no place can be found in the regular series system, since all predicted for prominent electronic configurations have been found, and any terms due to additional possible configurations would gives lines in infra-red or extreme ultra-violet. These faint lines can probably be ascribed to a secondary-series systems, with terms arising from configurations of type $(4_3)^8\ 5_1\ n_k$.

The analysis of the spark-spectrum has shown that $(4_3)^8\ 5_1$ and $(4_3)^9$ are of almost equal stability, and consequently terms of this type should occur with considerable prominence in the arc-spectrum, but might not combine readily with the regular terms.

An attempt to find a clue to this part of the spectrum by means of the inter-combinations has been unsuccessful, and no serious effort has been made to analyse it separately. Similar configurations are also likely to be prominent in the spark-spectrum, accounting for the very large number of lines, only a small fraction of which have been included in the present analysis.

The Mobility of Ions in Air. Part III. By A. M. TYNDALL AND L. R. PHILLIPS. Communicated by Prof. A. P. Chattock, F.R.S.

Measurements of the mobility of ions have been made in air containing organic vapours over a range of concentration extending up to saturation. In every case a reduction in mobility is produced by the addition of vapour, though the amount depends upon the constitution of the

The gradient of the mobility vapour general steep at low concentrations, but gous series of normal aliphatic alcohols the steepness increases as one ascends the series, the effect of the higher alcohol being very striking. Similar effects have been observed for the positive ion, but the initial drop in mobility is much less marked.

The factors entering into the cluster theory of gaseous ionic structure are

examined with special reference to the results. It is suggested that the relative effects of the various vapours depend upon (1) a "clustering coefficient" determined by the combined effect of any permanent electric moment and an induced electric moment in the neutral molecule (2) the effective diameter of the cluster.

Investigations on Paramagnetism at Low Temperatures. Part II. By L. C. Jackson. Communicated by Sir William Bragg, F.R.S.

A description is given of an apparatus for the determination of the principal susceptibilities of paramagnetic crystals at low temperatures. Orientated sections of the crystal are suspended in a non-homogeneous magnetic field and the forces exerted on them are measured by means of a Pettersson quartz micro-balance sensitive to 10^{-6} mgrm. The magnetic field is produced by a large accurately constructed coil and its value is determined from the current strength and the known dimensions of the coil. The low temperatures are obtained by a cryostat of the Keyes and Young type.

Data for the three principal susceptibilities of cobalt potassium sulphate are given for temperatures down to $-100°$ C. The principal susceptibility parallel to the symmetry axis of the crystal is also given for nickel ammonium sulphate and manganese ammonium sulphate. The principal susceptibilities all obey the law $\chi(T + \Delta) =$ constant over the range of temperature investigated.

Responses to Rhythmical Stimulation of the Cerebral Cortex. By Sybil Cooper and D. Denny-Brown. Communicated by Sir Charles Sherrington ,O.M., F.R.S.

Electrical and myographic records have been made of movement produced by rythmical stimulation of the cerebral motor cortex. Rates of 18 to 68 per second were used. In the electromyograms the primary waves follow the rate of stimulation, and secondary waves are at present giving an average total frequency of 120 per sec. The mechanical records show rhythmical tremor corresponding in frequency with rates of electrical stimuli applied to cerebral cortex, even at 68 per sec. This confirms, and extends to higher frequencies, the original observations of François-Franck and Pitres.

THE CHEMICAL SOCIETY.

June 17, 1926.

The Chemistry of Polycyclic Structures in Relation to their Homocyclic Unsaturated Isomerides. Part VII. Tautomerism Corresponding with that of Nitrosophenol and Quinoneoxime in the Dicyclo*pentane Series.* By A. Hassell and C. K. Ingold.

5-*cyclo*Hexane*spirocyclo*penten-3-ol-1 : 4-dione reacts with hydroxylamine forming 4 - oximino - 5 - *cyclo*hexane*spirocyclo*penten-3-ol-1-one, which is convertible by the further action of hydroxylamine into 1 : 4-dioximino - 5 - *cyclo*hexane*spirocyclo*penten-1-ol, and also by oxidation with ferricyanide into 4-nitro-5-*cyclo*hexane-0 : 1 : 2-*spirodicyclo*pentene-1 : 3-diol. The latter on methylation gives the same dimethoxy-nitro-compound as that which is obtained by the oxidation of the monoxime derived from 3-methoxy-5-*cyclo*hexane*spirocyclo*penten-1 : 4-dione and subsequent methylation. The monoximes are therefore capable of acting as 1 : 4-nitroso-hydroxy-compoundsa.

The Nature of the Alternating Effect in Carbon Chains. Part VIII. The Nitration of Some Benzylamine Derivatives with Special Reference to the Respective Rôles of the Ions, Salts, and Bases. By F. R. Goss, C. K. Ingold, and I. S. Wilson.

Determinations of the proportions of *m*-isomeride obtained in nitration, by 95% nitric acid, of 10 derivatives of benzylamine have been made.

A determination of the proportions of all three isomerides in the case of benzylamine itself gave :—*ortho*, 10% ; *meta*, 47% ; *para*, 43%. Diacetbenzylimide decomposes in strong nitric acid but in acetic anhydride substitutes mainly *p*-.

The Structure of the Normal Monosaccharides. Part V. Fructose. By E. L. Hirst.

Crystalline, normal tetramethylfructose first isolated by Purdie and Paul and afterwards examined by Irvine and Patterson contains an amylene oxide ring; thus the butylene oxide formula cannot be applied to normal fructose. On oxidation with nitric acid, normal tetramethyfruceose gave two well-defined products, *d*-arabotrimethoxyglutaric acid and *i*-dimethoxysuccinic acid (amides, m.p. 232-3°, and 245° respectively). The acid isolated by Irvine

and Patterson as the ethyl ester during their oxidation experiments was also obtained.

The Constitution of the Disaccharides. Part XI. The Relationships of Fructose, γ-Fructose and Sucrose. By W. N. HAWORTH AND E. L. HIRST.

Hirst's proof that normal fructose is an amylene oxide sugar places fructose in alignment with the normal aldoses and supports the generalisation that normal sugars exist as amylene oxide forms. Since it has previously been shown that γ-aldoses are butylene oxide sugars, tetramethyl-γ-fructose should by analogy correspond with this type. New experiments on the oxidation of tetramethyl-γ-fructose are communicated. The present position of the sucrose problem is reviewed in detail with special reference to the formulation of normal and of γ-fructose.

The Formation of phosphinic Acids from Triarylmethoxyphosphorus Dichlorides. By D. R. BOYD AND F. J. SMITH.

The authors have prepared the following triarylmethoxy-phosphorus dichlorides and examined their behaviour towards hydrolysing agents: $C(C_6H_5)_2(p\text{-}C_6H_4X).O.PCl_2$ where X = NO_2, Cl, Br, CH_3 or OCH_3; $C(C_6H_5)_2(m\text{-}C_6H_4.OCH_3).O.PCl_2$; $C(C_6H_5)_2(\alpha\text{-}C_{10}H_7).O.PCl_2$; $C(C_6H_5)_2(\beta\text{-}C_{10}H_7).O.PCl_2$.

These compounds are all stable towards cold aqueous alkali. Diphenyl-*p*-anisyl-phosphorus dichloride is slowly hydrolysed to phosphorous acid and diphenyl-*p*-anisyl carbinol by digestion for some hours with hot aqueous ammonia; the other chlorides are not altered by this treatment.

The behaviour of the phosphorus chlorides towards hot alcoholic potassium hydroxide is found to vary with the "basicities" of the carbinols from which the phosphorus chlorides are derived. A relatively low "basicity" favours molecular rearrangement (migration of $-CAr_3$ from O to P). A relatively high "basicity" leads to hydrolysis without molecular rearrangement. Thus $C(C_6H_5)_2(C_6H_4Cl).O.PCl_2$ (basicity of carbinol = 0.79) gave 93% of phosphinic acid. On the other hand, from $C(C_6H_5)_2(p\text{-}C_6H_4.OCH_3).O.PCl_2$ (basicity of carbinol = 6.52) and from $C(C_6H_5)_2$ $\alpha\text{-}C_{10}H_7).O.PCl_2$ (basicity of carbinol = 10.8) no phosphinic acid was obtained.

The yield of phosphinic acid obtained as a by-product in the preparation of a phosphorus dichloride by the action of phosphorus trichloride on a carbinol is greater in the case of the more strongly basic carbinols. This is in agreement with the view previously suggested, that the first step in the reaction between R.OH and PCl_3 is the formation of an additive compound; either $Cl_3P(OR)H$ or, when the carbinol has pronounced basic properties, $Cl_3P(OH)R$.

SOCIETY OF GLASS TECHNOLOGY.

The last meetings of the Society of Glass Technology for the Session 1925-26 were held in London on Tuesday and Wednesday, June 1 and 2, 1926. The meeting on Tuesday was held in University College, Gower Street, the President, Mr. Walter Butterworth, Snr., M.A., in the Chair, when a lecture and demonstration on "Glass in Early Ages" was given by Professor Sir W. M. Flinders Petrie, F.R.S. This meeting was attended by some of the touring members of the Stained Glass Association of America.

Professor Sir W. Flinders Petrie said that in his opinion no glass was made in Egypt prior to about 1500 B.C., all earlier specimens being imported. There was no question that the Syrians were far ahead of the Egyptians up to this period in the matter of art and industry, and one had little difficulty in attributing to the Syrians the glass wares which were imported into Egypt prior to 1500 B.C. Examples of glass had been found in Syria, in the Euphrates region, which could definitely be dated back to 2500 B.C. It was significant that only fifty years or so elapsed between a time when glass was a comparatively rare commodity in Egypt and a time when it was possibly the commonest commodity of all. Glass vases and glass beads rapidly came into everyday use. At first it was not a liquid glass which was produced, but a glass paste which could be moulded in the plastic state. No blown glass was found in Egypt until one came to the examination of the products of the Christian period. The aim of the early Egyptians was to produce something which would emulate precious stones. For this it was necessary to obtain the right colour, and the whole of the earliest glass wares discovered in Egypt were coloured.

It was not until about 1200 B.C. that the Egyptians began to make glass by pressing it into moulds, and from thence onwards, until the 7th century, B.C., the colour of their glassworks appeared to get worse and worse, although the patterns became more and more composite. It was not until after the Roman period that the problem was tackled of painting glass by the application of colours to the surface. From the year 350 A.D., the Egyptian glass makers resorted to the moulding of glass in the production of standard weight for gold coins, a practice which was later copied by the Arabs and which led to the development of a remarkable system of weights. About 730 A.D., there was a sudden outburst of accuracy in the production of weights, and three examples of glass weights had been excavated which agreed to within a 200th of a grain. Sir Flinders Petrie then went on to deal with the application of a glass or glaze to other materials. The glazing of stones appeared to have begun in Egypt about the 12th century B.C., and the Egyptians early learned the lesson that they must, at all costs, keep iron out of their glazes or else their colours would be lost. Some of the tiles covering the walls of early Egyptian chambers were magnificent examples of colouring. Not only single colours were achieved, but also polychromes.

In conclusion, the lecturer remarked that he was of the opinion that a good deal more knowledge of the history of glass might become available when Asia was really opened up for proper investigation and study. Then, and not until then, one might really get to know, for the first time what was the actual origin of glass making.

On the evening of June 1, the Annual Dinner of the Society was held in the Hotel Cecil. The guests included Sir Edward Manville (Master of the Glaziers' Company), Mr. Alex. L. Howard (Master of the Glass Sellers' Company), and sixteen touring members of the Stained Glass Association of America.

During the morning of June 2, the members of the Society had the privilege of visiting the Osram G.E.C. Glass Works and the Research Laboratories of the General Electric Company, Ltd., at Wembley. Lunch and tea were kindly provided and a general meeting was held in the afternoon in the Library of the Research Laboratories.

At this meeting the following papers were presented :—

Opal Glass. By J .W. RYDE. This was a communication from the Research Laboratories of the General Electric Company, Ltd.

Opal glasses could be divided into two groups, those which obscured a source of light placed behind them, and those through which a red image of the source was visible, the glass itself appearing bluish. The causes of opalesence were reviewed.

A number of commercial and experimental glasses were examined by the X-ray method in order to determine the nature of the opacifying material which separated out. From the X-ray patterns obtained it was shown that sodium fluoride and calcium fluoride had separated out from the glasses examined, the lime and soda contents of which were quoted. It was also found that from one glass no X-ray pattern was obtained and the opacity in this case was attributed to the presence of bubbles. In another glass containing very little lime, only sodium fluoride was found to have separated out. But as the lime contents of the glasses increased, calcium fluoride separated out in increasing quantities. Slides showed the patterns obtained. Some glasses that were suddenly chilled were almost clear, but had a bluish cast. In these the particles which separated out were very small. The rates of cooling were controlled, and varied so that the effect of the rate of cooling on the depth of opal produced could be investigated. With slow cooling the size of particles which separated out increased until a certain limiting size was reached. The optical properties of opal glasses were next discussed. To demonstrate the influence of opacifying particle size in the transmission of light, standard solutions were prepared which contained very fine white particles in suspension. By means of these solutions the effects of particle size and total mass of particles on the transmission of light were demonstrated. A solution with large particles appeared bright by transmitted light and dark by reflected light. Hence in bulbs made of opals in which the opacifying particles were relatively large, very little light was scattered back to transverse the bulb again.

The Electrical Conductivity of Glasses at High Temperatures. By F. F. S. BRYSON, M.A., B.Sc.

The electrical conductivity of several series of glasses was determined at temperatures between the softening point and 1150° C. The glass was heated in a small cylindrical crucible in a platinum wound electric furnace. A valve generator was used as a source of current, and a bridge method was employed for measuring the resistance between platinum electrodes immersed in the glass. The results showed that a considerable increase in conductivity was obtained when Na_2O was substituted for SiO_2 in a simple soda-silicate glass. In three component glasses the conductivity was increased by the substitutions of MgO for SiO_2, but lowered by the substitutions of Al_2O_3 for SiO_2 or for Na_2O. The temperature-resistance curves for several of the glasses bore a close relationship to the temperature-viscosity curves for similar glasses and suggested the possibility of using conductivity measurements as a method of determining changes in the viscosity of a glass immediately before bein gworked. An experimental arrangement was described, by means of which a record was obtained, on a millivolt recorder of the usual works type, of the variations in the conductivity of the glass flowing along the channel leading from the tank to a bottle-making machine.

The Influence of Moisture on the Rate of Melting and on the Properties of Soda-Lime Glasses. By EDITH M. FIRTH, B.Sc.; F. W. HODKIN, B.Sc; M. PARKIN, M.Sc. AND PROFESSOR W. E. S. TURNER, D.Sc.

This paper was presented by Professor Turner, who reported the results of experiments with four series of meltings, in two of which soda was introduced wholly as soda ash, in the other two, partly as saltcake. Moisture was present in amounts ranging from 0.25 to 15 per cent. in different batches. In general, the presence of a limited amount of moisture had a beneficial effect on the rate of melting. In the case of batches containing no saltcake the best amount appeared to be about 1 per cent. and not exceeding 2 per cent.; for batches containing saltcake, 3 to 4 per cent. The glasses made from batches containing saltcake were refined more easily and were freer from waviness than those prepared from batches containing soda ash only. Glasses prepared from batches containing more than a certain proportion of moisture were found to be more viscous and to have a shorter working range than those obtained from ordinary dry batches.

GEOLOGICAL SOCIETY OF LONDON.

At the meeting held on March 10, 1926, the following communications were read :—

The Pleistocene Deposits of the Lower Part of the Great Ouse Basin. By PROF. JOHN EDWARD MARR, Sc.D., F.R.S., For.Sec.G.S.

In a paper published in the Society's *Journal* (Vol. lxxv., 1919-20, p. 204), the author described the Pleistocene deposits in the immediate vicinity of Cambridge.

In the present paper a wider area is described. The results, in the main, confirm the conclusions of the previous paper.

It is argued that a period of aggradation in Lower Palæolithic times intervened between two periods of glaciation of the district, and that, subsequently to the second glaciation, erosion occurred, with minor periods of aggradation in Upper Palæolithic times.

The author also discusses the general character of the river-diversions which occurred in the district in Pleistocene times.

An appendix by Mr. A. S. Kennard and Mr. B. B. Woowdard deals with the non-marine mollusca.

DISCUSSION.

Mr. Reginald A. Smith remarked on the occurrence of Cave-period types on the surface, which was a warning to those who regarded all surface-finds as Neolithic. The larger flakes had been compared with the Belloy-sur-Somme series, which dated from late Aurignacian and early Solutréan times; and Prof. Commont had recognised the same industry at North Cray, where many large flakes had been found together unmoved, and were capable of being re-fitted together. Some of the smaller white flake-implements were rolled, and one with a different patina appeared to be of Magdalenian type. La Micoque was also represented elsewhere, as at Henley, Mr. Ll.

Treacher having presented a fine unrolled and sharply pointed implement to the *British Museum from brick-earth high* above the river-level.

Mr. H. Dewey remarked upon the similarity of the sections described by the author to some at Biddenham, in Bedfordshire, in gravels of the Ouse. There an earlier series of bedded gravel and sand, containing implements of Chellean, Acheulian, and Mousterian types, is overlain by unassorted stony wash in which large masses of Chalky Boulder Clay are not uncommon. A few years ago, some of these boulders were observed which had apparently been driven into the bedded gravel with such force as to break up the bedding. These features pointed to the formation of the upper series under cold conditions.

Mr. G. W. Lamplugh asked the author how the correlation of the supposed marine gravels of March with the river deposits now described had been reached. He had not himself chanced upon a good section of these gravels either at March or at Chatteris; but, from their characters, contents, and mode of occurrence, he regarded them as the equivalents of those of Kelsey Hill in Holderness, which he knew well and had sought to explain as glacial outwash material. He suggested that the Cambridge sequence of river-deposits may have been formed while an ice-sheet still persisted in the North Sea basin, and was contemporaneously shedding some of its burden over the country east of the Yorkshire and Lincolnshire Wolds. He deprecated the assumption that, because some of the beds contained a " temperate " fauna, the ice had all gone. There was much evidence that ice-sheets held the sea-basins east and west of this country during times when the low Midlands were bare, and he thought that, in our latitude, the climate during most of the year may then have been comparatively mild.

Cretaceous Glaciation in Central Australia. By WALTER G. WOOLNOUGH, D.Sc., F.G.S., AND PROF. SIR T. W. EDGEWORTH DAVID, K.B.E., C.M.G., D.S.O., D.Sc., F.R.S.

Evidences of glacial action in Central Australia were recorded more than forty years ago by the former Government Geologist of South Australia, H. Y. L. Brown. The evidence is mostly in the form of numerous erratics and occasional beds of tillite. Later Sir Baldwin Spencer, Dr. J. A. Watt, and the late Prof. Ralph Tate described the occurrence of undouhted glacial deposits in the heart of Australia at Yellow Cliff and Crown Point. Originally all these occurrences were referred to one and the same glaciation, assumed to be of Cretaceo-Tertiary or possihly Jurassic age.

As the result of later researches hy L. K. Ward and R .L. Jack, of the Geological Survey of South Australia, Prof. W. Howchin, Dr. H. Basedow, and the authors of this paper, it was demonstrated that the occurrences helonged to two distinct geological horizons, the older almost certainly Permo-Carboniferous, and the newer probably Jurassic to Cretaceo-Tertiary. Recently, one of the authors (W. G. W.) when exploring the salt-lakes of Central Australia on behalf of Brunner, Mond and Co., was fortunate enough to discover good evidence as to the age of the later glaciation. Recent observations hy Ward and Jack have shown that the erratics are distributed in vast numbers over an area of South Australia measuring about 200 by 100 miles. They vary in size from a foot or so up to 5 feet in diameter.

The most recent expedition (by W. G. W.) has led to the discovery by him of marine fossils in the same matrix as that in which the erratics are embedded. They consist of stems and calyx-plates referable to one of the Pentacrinidæ, and imperfectly preserved valves of pelecypods, mostly *Aucellina.* The erratic-bearing sandy mudstones show a considerable transgression across the marine Lower Cretaceous rocks containing very large specimens of *Crioceras*, and referred by F. W. Whitehouse to the Aptian horizon. The erratic-bearing beds, together with a thick series of freshwater strata with lignites, which mostly overlie the glacial deposits, are termed the Winton Series. They are followed by strata making locally a distinct unconformable junction with them and probably of early Tertiary age. These latter beds belong to the Eyrian Series, which in places carries fossil leaves of *Eucalyptus.* The occurrence of *Aucellina* and forms allied to *Isocrinus* in the Winton Beds at Moolawatina south-west of Lake Callabonna, north-east of the northern end of the Flinders Range of South Australia), added to the

above data, suggests contemporaneous glacial action in Middle Cretaceous time. F. W. Whitehouse opines that the age may approximate to Albian. If so, it would accord with the New Zealand evidence of a great orogenic movement in those islands soon after the close of Neocomian time. This revolution was accompanied by widespread intrusions of dunite and other igeneous rocks in New Zealand.

OFFICIAL PUBLICATIONS RECEIVED FROM THE U.S.A. BUREAU OF STANDARDS.

Permeability of Stone. By D. W. Kessler. Price 10 cents.

A Study of Case-ling Papers for the Purpose of Developing Standard Speciffcations. By B. W. Scribner, Technologist, and F. T. Carson, Assistant Physicist. Price 5 cents.

Properties of Potters' Flints and their Effect in White Ware Bodies. By E. E. Pressler and W. L. Shearer. Price 15 cents.

Pleistocene Plants from North Carolina. By Edward Wilbur Berry.

Mining in Colorado. 264 pp., with large coloured map. By Charles W. Henderson.

Fossil Proboscidea and Edentata of the San Pedra Valley, Arizona. By James Willams Godley.

Shore Phases of the Green River Formation in Northern Sweetwater Country, Wyoming. By Wilmot T. Bradley.

Surface Water Supply of the U.S.A. 1922. *Part VI. Missouri River Basin.* By Nathan C. Grover, Chief Hydraulic Engineer, and others. *Part XII, North Pacific Slope Drainage Basins. Part II., South Atlantic Slope and Eastern Gulf of Mexico Basin.*

Geology of the Baxter Basin Gas Field, Sweetwater Country, Wyoming. By Julian D. Sears (Geological Survey).

Geology of the Latah Formation in Relation to the Lavas of the Columbia Plateau, near Spokane, Washington. (Illustrated.) Also *Flora of the Latah Formation of Spokane and Cour D'Alene, Idaho.* (With several illustrations.)

Causes of Some Accidents from Gas Appliances. By J. Vernon Brumbraugh, Price 15 cents.

Cement-Lime Mortars. By H. V. Johnson. Price 15 cents.

A Photometric Method of Measuring the Hiding Power of Paints. By H. D. Bruce. Price 10 cents.

The Technology of the Manufacture of Gypsum Products. Price 30 cents.

Fire-Clay Bricks: Their Manufacture, Properties, Uses, and Specifications. Price 25 cents.

Possibilities for the Commercial Utilisation of Peat. By W. Odell and O. P. Hood. Price 35 cents.

FORTHCOMING EVENTS.

THE ROYAL INSTITUTION.

21, Albemarle Street, W.1.

Monday, July 5, at 5 p.m.—General Meeting of the Members.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

13,935.—Casale, L.—Preparation of mixtures of carbon monoxide and hydrogen from hydrocarbons. June 2nd.

14,091.—Fischer, F. — Purification of gases from sulphur. June 3rd.

13,831.—Gasparrini, O.—Manufacture of sodium chloride. June 1st.

13,731.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of dibenzanthronyls. May 31st.

14,205.—Jelly, E. E.—Production of sulphur dioxide gas. June 4th.

Specifications Published.

252,4†60.—Schmidt, Dr. K. F.—Methods for the production of amines, including the substitution prodncts thereof, and nitriles.

252,468.—George, W. J.—Clamping or supporting means for apparatus for use in scientific demonstrations.

234,104.—Hydrazote.—Methods for the manufacture of nitrogen or a mixture of nitrogen and hydrogen.

252,570.—Deppe Sohne, A., and Zeitschel, F. C.—Process for isolating alcohols or phenols from mixtures.

242,650.—Kyber, W. — Manufacture of phosphoric acid and generator gas.

Printed Copies of the full Published Specification may be obtained from the Patent Office, 25 ,Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

Abstract Published.

250,380.—Hydrogenation of cinchona alkaloids.—Howards & Sons, Ltd., Uphall Works, Ilford, and Blagden, J. W., Apple Tree House, Grove Road, South Woodford, both in London.

Hydrogenated organic compounds, catalytic production of; catalytic agents, preparation of.—Cinchona alkaloids or their derivatives are hydrogenated to the hexahydro compounds by treatment with hydrogen in the presence of a catalyst of the nickel group at a temperature above 30° C.; the hexahydro compound may be obtained from the dihydro compound in the same way. When starting with the non-hydrogenated alkaloid, the operation may first be conducted at ordinary temperature and then at a raised temperature. The catalysts specified are nickel, iron, cobalt and copper; the nickel catalyst may be prepared by reducing nickel carbonate with hydrogen at a low temperature, *e.g.*, 260° C. The starting material may be used as the base or a salt, and may be dissolved in water or an organic solvent under slightly raised pressure. Examples are given of the production of hexahydroquinone from quinine and dihydroquinone, and of hexahydrocinchonidine from cinchonidine.

The Latest TRADE MARKS

GASIL.

468,237.—Chemical substances used in manufactures, photography, or philosophical research and anti-corrosives.—J. Crosfield & Sons, Ltd., Bank Quay Warrington, Lancashire. June 2nd.

LYPTROL.

467,803.—Chemical substances used for agricultural, horticultural, veterinary and sanitary purposes.—Lyptol, Ltd., 2, College Road, Harrow, Middlesex. June 2nd.

JAD.

467,598.—Chemical substances prepared for use in medicine and pharmacy.—J. & D. Russell, The Cross, Stevenston, Ayrshire. June 16th.

HYPNOL.

469,095.—Chemical substances prepared for use in medicine and pharmacy.—Continental Laboratories, Ltd., 22d, Ebury Street, London, S.W.1. June 16th.

AVENYL.

469,632.—Chemical substances prepared for use in medicine and pharmacy.—The Wellcome Foundation, Ltd., 67, Holborn Viaduct, London, E.C.1. June 9th.

DUPRO BRAND.

469,167.—Chemical substances prepared for H. R. Napp, Ltd., 3 and 4, Clement's Inn, Kingsway, London, W.C.2. June 9th.

SURFACE CHEMISTRY.

Mr. E. K. Rideal, Lecturer in Physical Chemistry at Cambridge, has written *An Introduction to Surface Chemistry*, to which Professor F. G. Donnan has contributed a preface. The book will be published by the Cambridge University Press.

CHEMICAL SCALES

in Mahogany Case, Platinum Weights Complete. Second-hand Bargain. £5 5s. Richardsons, Jewellers, 145, Oldham Street, Manchester.

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THE LAW OF RELATIVE VOLUME.

By HAWKSWORTH COLLINS, B.A. (Camb.)

(*Continued from Page* 330, *Vol.* 132.)

TABLE X.
ZERO-VOLUME OF SODIUM.

	Atomic Weights.	Vols.	Part.vols.	Refer to Nos.
(156)	75(As) = 32(Na) + 40(Ca) + 12(C)	15.68	= 0 + 12.24 + 3.44	202, 93, 92.
(157)	75(As) = 23(Na) + 40(Ca) + 12(C)	18.94	= 0 + 13.25 + 5.69	203, 147, 96.
(158)	75(As) = 23(Na) + 40(Ca) + 12(C)	20.23	= 0 + 14.54 + 5.69	204, 88, 96.
(159)	111(Cd) = 46(Na_2) + 65(Zn)	11.76	= 2(0) + 11.76	208, 134.
(160)	111(Cd) = 46(Na_2) + 65(Zn)	13.66	= 0 + 1.9 + 11.76	209, 30, 134.
(161)	111(Cd) = 46(Na_2) + 65(Zn)	14.73	= 2(0) + 14.73	210, 106.
(162)	111(Cd) = 46(Na_2) + 65(Zn)	19.59	= 2(0) + 19.59	211, 104.
(163)	63(Cu) = 23(Na) + 40(Ca)	5.23	= 0 + 5.23	214, 58.
(164)	78(Se) = 46(Na_2) + 32(S)	17.43	= 0 + 1.9 + 15.53	220, 30, 93.
(165)	51(V) = 23(Na) + 28(Si)	13.02	= 0 + 13.02	228, 108.
(166)	69(Ga) = 46(Na_2) + 23(Na)	11.85	= 2(0) + 11.85	141, 78.
(167)	85(Rb) = 46(Na_2) + 39(K)	22.29	= 2(0) + 22.29	237, 117.

The part-volume of Na appears in the above Table as zero 17 times. The only possible explanation of this is that a portion of mass 23 has been absorbed by the remainder of the element in such a manner as to increase the density of the latter without altering its size.

In No. 156 the four atomic weights and the three volumes were fixed by the intricate interdependence of a very large number of facts many years before the discovery was made with regard to the zero-volume of Na. Similar remarks apply to all the other cases in Table X.

No amount of hypothesizing could have ever produced such an unexpected result. Any suggestion that there is a hypothesis in the matter should be accompanied by an exact statement as to where the hypothesis is supposed to be. Otherwise the suggestion is misleading to those who have no time to study the matter.

TABLE XI.
ZERO-VOLUME OF TITANIUM.

	Atomic Weights.	Vols.	Part-vols.	Refer to Nos.
(168)	136(Ba) = 96(Ti_2) + 40(Ca)	25.66	= 2(0) + 25.66	205, 113.
(169)	136(Ba) = 96(Ti_2) + 40(Ca)	23.98	= 0 + 9.44 + 14.54	206, 111, 88.

TABLE XII.
ZERO-VOLUME OF ZIRCONIUM.

	Atomic Weights.	Vols.	Part-vols.	Refer to Nos.
(170)	209(Bi) = 90(Zr) + 119(Sb)	21.29	= 0 + 21.29	207, 74.
171)	192(Ir) = 90(Zr) + 102(Rh)	9.05	= 0 + 9.05	234, 235.
(172)	191(Os) = 90(Zr) + 101(Ru)	9.05	= 0 + 9.05	236, 238.
(173)	194(Pt) = 90(Zr) + 104(Pd)	9.05	= 0 + 9.05	239, 143.
174)	232(Th) = 90(Zr) + 94(Cb) + 48(Ti)	13.84	= 0+8.82+5.02	240, 56, 21.
(175)	197(Au) = 90(Zr) + 107(Ag)	10.25	= 0 + 10.25	242, 243.

TABLE XIII.

ZERO-VOLUMES OF Mg, Si, Al, S, P and Ca.

	Atomic Weights.	Vols.	Part-vols.	Refer to Nos.
(176)	52(Cr) = 24(Mg) + 28(Si)	7.13	= 0 + 7.13	119, 97.
(177)	52(Cr) = 24(Mg) + 28(Si)	8.71	= 8.71 + 0	245, 81.
(178)	52(Cr) = 24(Mg) + 28(Si)	7.51	= 7.51 + 0	246, 163.
(179)	59(Co) = 27(Al + 32(S)	4.05	= 4.05 + 0	212, 68.
(180)	63(Cu) = 23(Na) + 40(Ca)	9.54	= 9.54 + 0	84, 38.
(181)	55(Mn) = 28(Si) +27 (Al)	7.13	= 7.13 + 0	215, 97.
(182)	55(Mn) = 28(Si) + 27(Al)	13.02	=13.02 + 0	216, 108.
(183)	55(Mn) = 28(Si) + 27(Al)	11.53	=11.53 + 0	217, 94.
(184)	107(Ag) = 12(C) + 63(Cu) + 32(S)	9.78	= 0.71 + 9.07 + 0	222, 85, 223.
(185)	107(Ag) = 12(C) + 63(Cu) + 32(S)	10.25	= 0.71 + 9.54 + 0	224, 85, 84.
(186)	51(V) = 24(Mg) + 27(Al)	9.05	= 0 +9.05	225, 82.
(187)	51(V) = 24(Mg) + 27(Al)	8.71	= 8.71 + 0	226, 81.
(188)	51(V) = 24(Mg) + 27(Al)	7.51	= 7.51 + 0	227, 163.
(189)	59(Ni) = 28(Si) + 31(P)	7.13	= 7.13 + 0	230, 96.
(190)	59(Ni) = 28(Si) + 31(P)	11.53	=11.53 + 0	231, 94.
(191)	59(Ni) = 28(Si) + 31(P)	14.56	= 0 +14.56	232, 145.
(192)	48(Ti) = 24(Mg) + 24(Mg)	13.69	= 0 +13.69	241, 95.

TABLE XIV.

ZERO-VOLUMES OF H AND H_3.

	Atomic Weights.	Vols.	Part-vols.	Refer to Nos.
(193)	16(O) = 7+1+3+1+3+1	4.45 =	1.54+0.97+0+0.97+0+0.97	139, 143.
(194)	16(O) = 7+1+3+1+3+1	2.51 =	1.54+0.97+0+0+0+0	77, 143.
(195)	32(S) =23+1+3+1+3+1	10.51 =	9.54+0.97+0+0+0+0	74, 38, 143.
(196)	32(S) =23+1+3+1+3+1	7.51 =	6.54+0.97+0+0+0+0	130, 71, 143.
(197)	31(P) =23+1+3+1+3	10.51 =	9.54+0.97+0+0+0	218, 38, 143.
(198)	28(Si) =23+1+3+1	17.61 =	11.85+5.76+0+0	221, 78, 106.
(199)	27(Al) =23+1+3	23.7 =	23.7+0+0	229, 76.
(200)	27(Al) =23+1+3	29.46 =	23.7+5.76+0	247, 76, 106.
(210)	56(Fe)=28(Si)+27(Al)+H	6.94 =	3.2+3.74+0	233, 51.

In the Structure of Iodine (*Chem. News*, 1926, CXXXII., 165), several other examples of zero-volumes of H and H_3 were given. They are not repeated here merely on account of the difficulty of doing so shortly.

In Nos. 193 and 194, 1.54 appears for the first time as a part-volume of the monad lithium, which can therefore have the same volume as the two other monads H_3 and Na.

TABLE XV.

SUBSTANCES EMPLOYED IN ABOVE TABLES, ADDITIONAL TO THOSE IN TABLE IX.

	Relative Volume.	Theor. S.G. at 15°	Obs. S.G.	
(202)	As 15.68	4.78	4.71	Rettendorff
			4.91	Spring
(203)	As 18.94 in aq. sol.	(*C.N.*, 1924, CXXIX., 206.)		
(204)	As 20.23	3.707	3.70-3.71	15° Ruckoldt
(205)	BaF_2 25.66 + 2(5.42)	4.77	4.833	Schroder
			4.58	13° Bodeker
(206)	BaS 23.98 + 15.58	4.25	4.25	15° Nostrand
(207)	BiI_3 21.29 + 3(27.75)	5.644	5.64-5.65	20° Gott
(208)	CdF_2 11.76 + 2(5.42)	6.6	6.64	Nostrand
			5.992	22° Kebler

(209)	Am_4CdCl_6 4(23.87) + 13.66 + 6(15.085)	2.0	2.01	Johnsen
(210)	$CdCl_2$ 14.73 + 2(15.085)	4.05	4.05	25°/4 Nostrand
(211)	$CdCO_3$ 19.50 + 8 + 7.53 + 2(2.51)	4.260	4.258	Schroder
(212)	$CoCl_3.4NH_3.H_2O$ 4.05 + 3(15.085) + 4(18.11) + 14.03	1.85	1.847	Jaeger
(213)	$CuSO_4$ 9.54 + 15.53 + 2(7.53 + 2.51)	3.524	3.527	16° Pape
(214)	CuS 5.23 + 15.53	4.58	4.59	Chem. Kal.
(215)	MnO_2 7.13 + 7.53 + 2.51	5.07	5.04	Dana
(216)	$MnSO_4$ 13.02 + 15.53 + 2(7.53 + 2.51)	3.1	3.1	14° Bodeker
(217)	MnS 11.53 + 10.51	3.95	3.95	Leonhard
(218)	WP_2 21.59 + 2(10.51)	5.8	5.8	Nostrand
(219)	W_2S_2 2(21.59) + 15.53 + 10.51	6.24	6.26	20° Schafarik
(220)	Se 17.43	4.475	4.47	25° Nostrand
(221)	SiO_2 17.61 + 2(2.51)	2.651	2.651	Breithaupt
(222)	$AgSn_2$ 9.78 + 2(16.02)	8.2	8.223	16° Holzmann
(223)	Cu_2S 2(9.07) + 10.51	5.52	5.521	Scheerer
(224)	Ag 10.25	10.44	10.4476	Baudrimont
(225)	V_2O_3 2(9.05) + 7.53 + 2(2.51)	4.89	4.87	18°/4 Nostrand
(226)	V_2S_2 2(8.71) + 2(10.51)	4.318	4.2 - 4.4	Kay
(227)	VCl_2 7.51 + 2(15.085)	3.238	3.23	18° Roscoe
(228)	VCl_4 13.02 + 4(23.01)	1.837	1.836	8° Roscoe
(229)	$AlBr_3$ 23.7 + 3(27)	2.55	2.54	Deville
(230)	Ni 7.13	8.275	8.279	Richter
(231)	$NiSO_4.7H_2O$ 11.53 + 35.61 + 7(14.03)	1.933	1.931	Schiff
(232)	$NiSO_4.6H_2O$ 14.56 + 30.59 + 6(14.03)	2.034	2.031	15° Thorpe
(233)	Fe 6.94	8.07	8.007	10° Schiff
			8.139	15°.5 Smith
(234)	Ir 9.05	21.21	21.15	Deville
			21.78	Boye
(235)	Rh 9.05	11.27	11.2	Cloud
			12.1	Deville
(236)	$IrOs_4$ 5(9.05)	21.12	21.118	Berzelius
(237)	$RbBr_2I$ 22.29 + 2(23.09) + 27.75	3.86	3.84	Wells
(238)	Ru 9.05	11.16	11.0 - 11.4	Deville
(239)	Pt 9.05	21.44	21.45	Berzelius
(240)	$Th(SO_4)_2.9H_2O$ 13.84 + 2(35.61) + 9(14.03)	2.77	2.766	15° Nostrand
(241)	Ti 13.69	3.506	3.5	Chem. Kal.
			3.543	Nostrand
(242)	Au_2Ag 3(10.25)	16.3	16.354	13° Matthiessen
(243)	AuAg 2(10.25)	14.83	14.870	13° Matthiessen
(244)	$AuAg_2$ 3(10.25)	13.4	13.432	14°.3 Matthiessen
(245)	Cr_2S_3 2(8.71) + 3(10.51)	4.09	4.092	Playfair
(246)	Cr 7.51	6.92	6.92	20° Nostrand
(247)	$Al_2I_6.12H_2O$ 2(29.46) + 6(27.75) + 12(14.03)	2.62	2.63	Chem. Kal.

It has been shown that the probability that one of the coincidences in Table I. would happen accidentally is 1 : 250,000 (at least). The probability that two would happen accidentally is not *1 : 2(250,000)*, but 1 : the square of 250,000, *i.e.* 1 : *thousands of millions. If the probability* that one would happen accidentally could be reduced by some considerations as low *as 1 : 1,000, even then the probability that*

three would do so would be 1 : one thousand million. This means that it is quite impossible for as many as three out of about 200 to happen accidentally. It is therefore evident that the truth has been obtained.

Another proof of the truth of the matter can be obtained by the following consideration :—If the matter is not true, it would be impossible to find any hidden regularity in it. If it is true, the probability is that something deeper may be obtained from it.

The next paper will contain a truth which has been discovered owing to the exact discoveries of the laws of heat of formation and relative volume.

(To be Continued.)

BRITISH ASSOCIATION—SECTION B.

DISCUSSION ON THE ALTERNATING EFFECTS IN CARBON CHAINS.

September 1st, 1925.

(Summary of the Positions taken up by the Different Participants in the Discussion.)

PROFESSOR C. K. INGOLD.

Alternating effects in carbon chains were first recognised in 1902 by Flürscheim, who postulated free and bound affinity in each atom. Drawing off affinity in one direction from an atom decreases its affinity for the next atom in the chain, and thus produces alternating effects.

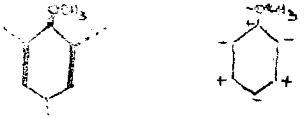
It is assumed that ordinary aromatic substitution consists in addition at a point and subsequent elimination, and the theory thus leads to the *o-p* and *m-* directive properties of various groups, whose relative strengths are deducible from their additive powers. The character of the benzene nucleus, however, is intermediate between the ethylenoid and saturated natures, and Flurscheim's idea of addition at a point leaves out of account the ethylenoid properties, which are certainly exhibited in certain cases, *e.g.*, the addition of ozone, of chlorine in sunlight, the tautomeric changes of phenols into ketones and the addition of metallo-derivatives to nitro compounds. The last is comparable with

$$R \cdot CH = CH.NO_2 + NaX = R.CHX.CH = NO_2Na$$

the residue X entering β (= 'ortho') to the NO_2 group.

These processes have nothing in common with processes depending on addition at a point. One cannot obtain an absolutely complete explanation of the properties of the benzene nucleus without taking into account its tautomerism. Flürscheim's theory, however, does not break down, for it is unequivocal and strictly tenable within very wide limits.

Electronic developments of Flürscheim's theory claim (a) to cover a wider field and (b) to supply a deeper physical interpretation. Lapworth's theory, put forward in 1922, left open the physical interpretation of partial valencies, but the theory embraced and extended the Flürscheim conception, or attempted to do so. The free affinity assumed by Flürscheim to be present on the *o-* and *p-* carbon atoms in such a compound as anisol is regarded by Lapworth as negative



and the groups which enter these positions (even Cl, Br, etc.), are regarded as positive. In addition, however, the theory would seem to indicate that positive affinity may arise in the *m*-position; but evidence of the direct introduction of negative groups, *e.g.*, OH, in the *m*-position is conspicuous by its absence. The electrolytic oxidation of phenals to dihydric phenols gives exclusively *o-* and *p-* derivatives.

Robinson's views lead to much the same results on a more definitely electronic basis. It is supposed that the electrons round the key atom close in on it and render it more negative, the next atom becoming more positive, and so on; a series of polarities is thus formed. A deduction from this mechanical explanation of alternate polarities is that if the alternate squeezing and relaxation gives real negative and positive charges, then the greater the squeezing the more marked should be the orienting effects. Work now being carried out on the two series F>O>N and Fl > Cl > Br > I seems to indicate, however, that the order should be inverted.

The later mechanical views of Robinson suppose that the oxygen of anisol, for

example, by giving up electrons to the ring, causes pairs of electrons to protrude in the *o-p-* positions. From a practical standpoint this gives the same result as Flürscheim's conception, but it professes to give a deeper physical insight. Physical tests must decide how close is the approach to physical reality. According to the modern physical theory of dielectrics plastic systems of electrons readily yielding to displacement should connote a high specific inductive capacity, but there appears to be no demonstrated relationship between this constant and the appearance of those chemical properties on the grounds of which it is assumed that the electrons are in an especially loose and active condition.

PROFESSOR D. R. BOYD.

The phenomena of hydrolysis have played an important part in the development of the theory of induced alternate polarities. Professor Robinson has stated that the condition which facilitates the hydrolytic fission of a molecule -ab- into -aH and HOb- is that *a* should be electronegative and *b* electro-positive either because of their inherent character or as the result of an induced alternate polarity effect. The stability of ether

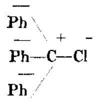
$$(CH_3.CH_2.\bar{O} \vdots CH_2.CH_3)$$

as compared with ethyl acetate

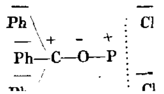
$$(CH_3.CH_2\text{-}\bar{O}\text{-}\bar{C}.CH_3)$$
$$\|$$
$$\bar{O}$$

is supposed to illustrate this law.

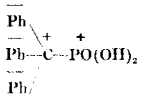
Assuming the phenyl group to be key-negative the mobility of the chlorination in triphenylchloromethane is readily explained on this view.



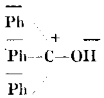
But the theory is in direct conflict with the behaviour of triphenyl methoxyphosphorus dichloride.



This compound is much more stable under other substances of the same type, and when reaction occurs under the influence of alcoholic potassium hydroxide, the positively charged carbon atom of the triphenylmethyl group attaches itself to the positive phosphorus rather than to a negative hydroxyl group; giving for the most part,



and not



A comparison of the behaviour of the phosphorus and phosphoric esters of di-*phenoxy-iso-propyl alcohol towards alkaline* hydrolysing agents shows also very clearly the untenability of Professor Robinson's hypothesis.

$$(PhO.CH_2)_2CH\text{—}\bar{O}\text{—}P\begin{matrix}\diagup OH \\ \diagdown ONa\end{matrix}$$

Easily hydrolysed by NaOH.

$$(PhO.CH_2)_2CH\text{—}\bar{O}\text{—}\overset{+}{P}\begin{matrix}\diagup HO \\ \diagdown ONa\end{matrix}$$
$$\|$$
$$\bar{O}$$

Very stable towards NaOH.

PROFESSOR E. C. C. BALY.

The observed reactivity of ammonia, which Dr. Flürscheim had compared with that of nitrogen, is really the reactivity of moist ammonia, as Baker's work has shown. Again, Sugden used moist benzene which has a much lower boiling point than the intensively dried liquid; on drying, the two molecules lose energy, and assuming this is one quantum per molecule, the calculated boiling point of pure benzene is 119.1°, whereas the highest observed value is 118.6°. Sugden will undoubtedly find a different value for the parachor of the double bond in benzene when he uses the intensively dried liquid.

Phillips' sulphinic ester may owe its optical activity to a reactive state in which it is kept by impurities.

REPLIES.

PROFESSOR T. M. LOWRY.

The cases quoted by Professor Boyd, in which a different behaviour is observed in compounds containing the groups $>C=O$ and $>P=O$ merely confirm Sugden's contention that the two types of union represented by these conventional symbols are entirely different in character, since the double bond between carbon and oxygen is non-polar and unsaturated, whilst the double bond between phosphorus and oxygen is semi-polar and saturated, since it cannot add on a pair of radicals without violating the octet rule.

PROFESSOR R. ROBINSON.

Ingold's statements as to the speaker's theory concerning the appropriation of electrons are incorrect. With regard to Professor Boyd's experiments, one cannot deduce the ease of reaction from any assumed mode of its occurrence, the real mechanism being unknown.

DR. B. FLURSCHEIM.

(Time allowance, 4 minutes.)

To Professor Baly: The frequencies of electrons are their number of revolutions per second, not the frequency of emitted light.

To Professor Lowry: Lowry's remarks were very interesting, but they did not deal with any of the facts advanced against him.

To Professor Ingold: The speaker is in agreement with Professor Ingold on most points; it is, however, unnecessary to postulate more than a single mechanism to account for the substitution of a hydrogen atom in the benzene nucleus, *viz.*, the point addition at places of maximum free affinity postulated by the affinity theory. Reactions of potassio-salts, such as KCN, with nitro compounds, etc., primarily leads not to a substitution product, but to a reduction product of a substitution product. This also covers one of Robinson's arguments.

To Professor Lapworth: The suggestion that the separation of charges and the transformation of a stable benzenoid into an unstable quinonoid form (assumed by Lapworth and Robinson)is to be brought about by mere mass action, does not appear very convincing.

To Professor Robinson: One of the exceptions brought forward against Robinson was, not that CI_4 was transformed to CHI_3 by KOH, but by HI, "negative" I uniting with "negative" I, and "positive" H with "positive" C. Professor Robinson's explanation that p-nitration of tert-butylbenzene (contrary to the m-directive effect of his mechanism III) is due to the superposition of one of his other mechanisms, is unacceptable, since none of these other mechanisms is applicable in the present case. The suggestion that the migration of Cl in p-hydroxyphenyl-iodochloride to a position adjoining hydroxyl is due to primary separation of free chlorine is equally untenable since Dr. McCombie has observed this change to occur in the solid without liberation of chlorine. It is noteworthy that where point addition precedes substitution, the position taken up is independent of the "polarity" of the entering group; thus in nitration in presence of mercury nitrate the "negative" hydroxyl-group takes up the same position which is ordinarily taken up by the "positive" nitro-group.

HELIUM DEVELOPMENT LIKELY.

Commercial development of helium gas in Ontario on a large scale is expected to result from experimental work that the Provincial Department of Mines, in co-operation with the University of Toronto, is to carry out this summer at the Government's land at Inglewood, where helium gas was found during the war, but kept secret until a few months ago.

WATER POWER.

REMARKABLE DEVELOPMENTS IN HYDRO-ELECTRIC PLANT.

By A WELL-KNOWN ENGINEER.

Most people in Great Britain have not yet realised that a complete revolution is in progress throughout the world with regard to the production of electricity, and that water power is making such enormous strides that coal is no longer supreme. It will be remembered that atmospheric nitrogen fixation was first developed in Norway because of the cheap electricity available due to water power, but during the past five years this clean and scientific method of utilising the latent energy in falling water, whether at high or low levels, is being rapidly applied in practically every

industrial and semi-industrial country. The principle has many important advantages, such as extremely small wear and tear, maintenance, and labour costs, and no troubles with ash and clinker, while schemes of this character constitute a safe and steady investment, and receive special protection and assistance by Governments, because of their great national importance. There is therefore no difficulty in raising the capital, and already hundreds of millions of pounds of capital are coucerned in the matter.

It is chiefly for this reason the total production of coal throughont the world has now been stationary for several years past at about 1,240,000,000 tons per annum, whereas the use of petroleum, oil, and especially water power is growing by leaps and bounds. To-day over 35,000,000 H.P. is being generated by water power, while in 1920 the figure was 23,000,000 H.P., and at the end of 1923 this had risen to 29,000,000 H.P. Thus in 1926 600,000 H.P. was started up in Canada, and 1,500,000 H.P. in the United States, the latter country now having plant of over 15,000,000 H.P.

Taking approximate average round figures spread over a number of years past, Great Britain produces 250,000,000 tons of coal per annum, about 20% of the world's production, and sells 62,500,000 tons—abroad and to steamships. As showing the difficulty of maintaining the export, in 1921 all Europe together, our best customer for coal, was using 8,877,000 H.P. from water, but in 1923 the figure was 12,300,000 H.P., or nearly 40% increase.

Not only is almost every country in Europe developing water power on a huge scale, and therefore requiring less coal, but the same applies all over the world, the United States, Canada, Japan, India, Siam, Ceylon, New Zealand, Tasmania and Brazil, to take a few cases.

The main remedy for the British colliery industry in order to compensate for the loss in revenue which is bound to become more acute is increased scientific methods, especially in the wholesale carbonisation of onr rich bituminous coal and the home production of petrol and heavy oils for Diesel engine working, as well as smokeless fuel, which would give a far greater revenue than selling our precious raw coal abroad in a hopeless struggle with modern methods such as water power. The remarkable work in Germany on the production of "Methanol" and "Cynthol" is an indication of what is necessary, and undoubtedly the burning of raw coal is doomed.

General Notes.

TURKISH PHARMACOPŒIA TO BE DRAWN UP.

The Board of Trade have now received copy of a Law, dater 3rd March, which provides for the appointment of a Commission to draw up a Turkish Pharmacopœia ("Codex Turc").

The Commission is to draw up lists specifying, in Turkish, French and Latin, all medicinal plants and all chemical products, simple or compound, organic or inorganic, used in human or animal medicine; lists indicating the chemical composition of such plants and materials; the method of their preparation; their physical and chemical properties, characteristics, etc.; methods of analysis to be applied to ascertain their purity and to discover adulteration or substitution; maximum and minimum doses, etc.

The Pharmacopœia, when prepared, will be put into force by Presidential Decree, and all chemists and druggists will be bound by its provisions. All examinations and analyses by druggists and chemists and in the Customs are to be made on the basis of this Pharmacopœia.

The Commission is to meet at five-year intervals, to make any necessary modifications in the Codex.

The Text of the Law (in French) may be seen by persons interested on application to the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1.

CANADIAN PLANT MAKES COMMERCIAL SHIPMENTS OF NATURAL SALT CAKE.

In a previously-published news letter prepared in November last, Dr. A. W. G. Wilson, of the Mines Branch, Department of Mines, Ottawa, directed the attention of textile dyers to the manufacture of spray-dried salt cake now being produced in Western Canada, and particularly in the Province of Stskatcrewan, from the large

deposits of natural Glauber salt found in the *alkaline lakes of that region. This product in its natural state is entirely free from acid and iron, a quality essential in salts used in the dyeing of woollen or cotton fabrics, and is much superior to the by-product recovered in the manufacture of muriatic acid.*

The deposit of Glauber salt from which the dehydrated material is prepared by the Spray-dryer process is located at Frederick Lake, thirty-eight miles south-west of Moose Jaw, Saskatchewan, and it is being worked by the Bishopric and Lent Company. Hydrous crystals harvested from the surface of the deposit are stored in a stock pile adjacent to the plant. In the plant the natural crystals are dissolved, and the solution is filtered. The clarified and heated brine is then pumped to the top of a tower and sprayed through special nozzles. Hot gases from oil burners are admitted at the bottom of the tower and the finely atomised brine, falling through the rising gases, loses its water so that dehydrated sodium sulphate in the form of a fine powder is collected at the base of the tower, the percentage of moisture left in the product being regulated by the temperature of the rising gases.

Two forms of salt cake are produced. The first, a white fluffy powder, containing less than one half per cent. of moisture and weighing aproximately thirty pounds per cubic foot, is obtained directly from the drying tower. This material finds a ready market in the dye industry. The second product, a nodulised sodium sulphate, weighing around ninety pounds per cubic foot ,is produced by partial spray drying followed by fusion in a rotary drier. This second produet finds a market in kraft pulp mills.

A survey of the lakes in Western Canada which contains beds of natural sodium sulphate has just been completed by the Mines Branch. It is estimated that there is a reserve in excess of one hundred million tons available for commercial development.

TOTAL FOREST PRODUCTION OF CANADA, 1924.

As in previous years, logs and bolts for domestic manufacture, the raw material of the saw-milling and allied industries, head the list of products for Canada as a whole with a total value exceeding eighty-three million dollars. These logs and bolts also *head the lists, as far as value is concerned, in the provinces of British Columbia, Ontario and New Brunswick. Pulpwood for use in Canada's pulp and paper mills comes second on the list for the Dominion with a total value exceeding forty-four* millions. Pulpwood is the most valuable item of forest production in the province of Quegee. Firewood, with a total of over thirty-nine million dollars comes third on the list for the Dominion as a whole, but heads the list in the three prairie provinces Nova Scotia and Prince Edward Island. Pulpwood for export, with a total value of thirteen and a half million; railway ties with fourteen million; logs for export with almost five million; square timber with three million and telegraph and telephone poles with over three and a half million dollars are among the more important of the other items. The total estimated value of all these primary forest products is $213,146,710, an increase of 7.9 per cent. over the estimated value for 1923.

It is estimated that the total primary forest production in 1924 involve the cutting of 2,808,506,073 cubic feet of standing timber. This constitutes only the consumption for use, and to it must be added the volume of material destroyed by fire, inseets, fungi, windfall, and other destructive agencies, which would bring the total depletion to more than 5,000,000,000 cubic feet per annum.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

Papers read on Thursday, June 17, 1926.

A Review of Mr. George W. Walker's Magnetic Survey (1915). By Sir Arthur Schuster, F.R.S.

Recent magnetic surveys, whether extended over the whole surface of the earth or confined to limited areas, seem to show that the components of magnetic force cannot be completely represented by a potential function, but indieate electric currents cutting the surface of the earth with current densities that are far greater than those obtained from direct measurement. The author has examined the

material supplied by Mr. Walker's magnetic survey, in order to form some judgment with regard to the best procedure to be adopted, so as to obtain a decisive test of the reality of these currents. The balance of evidence seems to favour a careful examination of a comparatively small area, rather than an extensive survey of districts as large as those into which the country was divided by Walker.

It is shown that if observations are taken at four stations, two of which lie in the meridian, and two on a circle of latitude, each station being at a distance of 1.8 miles from the central point, the density of the earth-air current may be determined with a probable error of 0.1 ampere per square kilometre, on the assumption that the difference between the magnetic components at two of the stations can be determined with a probable error of 3 γ in a single comparison, and that the observations are repeated 25 times.

The mean current density derived from Mr. Walker's survey of eight separate districts is 0.24.

The Continuous Spectrum of Mercury Vapour in Relation to the Resonance Line, 256.52. By LORD RAYLEIGH, F.R.S.

This paper discusses the various features of the mercury spectrum in the neighbourhood of the resonance line 2536.52 $1S—1p_2$, and in particular the relation of this line to the continuous spectrum, extending over the whole region from near this point to the green and even into the red.

The continuous spectrum can be produced without the resonance line, by fluorescent excitation with the aluminium spark, as originally observed by Wood. Under these conditions, it is found that the continuous spectrum ends at 2535.9, thus about 0.6 Angström on the short wave-length side of the resonance line. In this case the resonance line appears dark on the continuous background. The band at 2540 also appears sharply reversed on this background.

The same continuous spectrum can be obtained in absorption. In this case the measured limit was 2535.5, thus 1 Angström on the short wave-length side of the resonance line. But with a diminished quantity of absorbing vapour, the limit would probably be at the same position as for the emission spectrum.

By lowering the density of the vapour, the spectrum with aluminium spark excitation line 2536.52 and the band 2540 now appearing bright on a comparatively dark background. The same effect is obtained by electric discharge in fairly dense vapour, if the exposure is not too heavy. Reproductions of the various spectra accompany the paper.

Structure in the Secondary Hydrogen Spectrum. IV. By O. W. RICHARDSON, F.R.S.

A more detailed examination of the spectrum of the first type discharged has shown that there are a number of other lines which belong to the same system as Fulcher's bands. It is proposed to rearrange these lines so that S_3 to S_{-1} form a Q branch, S the first line of an associated R branch to which there is a corresponding P branch, S_6 and S_{-6} the first two lines of an associated Q' branch, and S_7 the first line of an associated R' branch to which there is a corresponding P branch. This holds throughout the first five of the six red bands. Four similar bands occur in the green and five in the blue; but the branches in those regions which would correspond to the dashed letters have not yet been located with certainty. There is a combination such that $R(m) - P(m+1)$ has the same value for corresponding lines of corresponding bands in the red, the green, and the blue. The quantum structure of the bands is not fully determined, but it is shown that they can be represented by terms of integral and semi-integral type. Reasons are given for believing that the emitter of this band system is the neutral hydrogen molecule H_2 formed and excited by the combination of the ionised hydrogen molecule $H_2{}^+$ with an electron.

The Structure of Beryl, $Be_3\ Al_2\ Si_6\ O_{18}$. By W. L. BRAGG, F.R.S., AND J. WEST.

Beryl has the composition of a metasilicate, the ratio of silicon to oxygen atoms being one to three. It is interesting to note that there are no SiO_3 groups in the compound. Silicon is surrounded everywhere by four oxygen atoms arranged tetrahedrally, resembling the arrangement in orthosilicates, such as olivine, monticellite, and garnet. The group SiO_4 shares an oxygen atom with each of two neighbouring groups, thus attaining the correct ratio of silicon to oxygen. Beryl thus is intermediate between the orthosilicates on the one hand, where each SiO_4 group is distinct, and quartz (W. H. Bragg) and christobalite (Wyckoff), where every oxygen group is

The hexagonal beryl has a structure like a honeycomb, hexagonal axes passing down empty channels at the centres of cells, whose walls are formed of densely packed oxygen atoms grouped around Be, Al, and Si atoms. No atomic centre is closer than 2.55 A to a hexagonal axis.

The analysis of the structure, which has seven parameters, is carried out in a direct manner by quantitative measurements of intensity of reflexion. The results are subjected by Fourier analysis (by the method of Duane) and give a determination of the electron density throughout the crystal which may be compared with the atomic arrangement.

On the Change of Refractive Index of Linseed Oil in the Process of Drying and its Effect on the Deterioration of Oil Paintings. By A. P. Laurie. Communicated by Sir Arthur Schuster, F.R.S.

These researches were undertaken for the Committee which has been set up by the Royal Academy, for investigating modern pigments and mediums, to throw more light on the tendency of the modern oil picture to lower in tone.

This is partly due to the yellowing of the oil film, but this does not seem to entirely account for the changes that take place. These investigations were made to ascertain if the oil film changes in refractive index, since it is obvious that in course of drying and in its subsequent history the oil film rises in refractive index, the pigments ground in it becoming more translucent and deeper in tone.

The inquiry took two directions :—

(1) The examination of certain pigments by grinding them in liquids of various refractive indices, higher than linseed oil, noticing the change of tone and examining under a microscope so as to roughly classify them in order of translucency. In this way a table was drawn up as a rough guide to the artist. White-lead, for instance, ground in bromo-naphthalene, consists of transparent doubly refracting crystals.

(2) In order to test change of refractive index, an oil film was painted out on the glass of a Smith refractometer and observed from time to time. During drying the index rose from 1.480 to 1.490. Since then the film has been observed for some eight or nine months, and the index is now over 1.500, a change which produces a visible effect on white-lead and pale yellows.

As it is known that the linseed-oil film continues slowly to change and contract for many years, this slow change of refractive index no doubt continues. Light is thus thrown on the method of painting in oil by the 15th Century painter, who laid down a scheme in black-and-white or brilliant colour in a medium of low refractive index, and glazed over this with thin oil paint, thus securing that as the pigments became more translucent more light would be reflected from the painting below, thereby keeping up tone and brilliancy in his pictures.

CHEMICAL, METALLURGICAL AND MINING SOCIETY OF SOUTH AFRICA.

The Education of Chemists

At the Ordinary General Meeting of the Chemical, Metallurgical and Mining Society of South Africa at Johannesburg, on April 17, 1926, Dr. William Cullen delivered an address on the above subject, and also on sulphuric acid and the conditions of explosives during the past ten years.

Why Chemists Do Not Reach High Administrative Posts.

After some introductory remarks, Dr. Cullen said that he was now speaking of England, not of South Africa. Probably the same thing applied here, but he was not in a position to judge. When one made a general survey of the membership of those large societies on the other side, such as the Society of Chemical Industry, with a membership of 5,000, and the Chemical Society, with a membership of very nearly the same, and the Institute of Chemistry, with a membership of only a few less, one was struck by a very notable fact; it was this, that comparatively few of those people reached high administrative posts; in fact, the majority stuck in the laboratory and did not become managers or directors. That was a fact that one had got to face.

Another fact which they had got to face was this, that the industrialists and the manufacturers who employed these chemists had not come out into the open, nor had they been able to get them out into the open, in order to specify what kind of curriculum those chemists should pass

through in order to make themselves more useful in industry. Those were two broad facts.

A third one was this—and it was generally conceded, not by chemists but by people who dealt with chemists—that the products of the Universities in England to-day were extremely narrow-minded, non-enterprising, and lacking in initiative. (Hear, hear.)

Those were very broad accusations, and, of course, there had been a great many nostrums to put them right. Some very vocal persons said the only way to make a chemist a useful member of industrial society was to make him an engineer. Another group of people said that he must be an economist. Well, it was a fact that chemistry was, to-day, perhaps the most complex of all the sciences. Its horizons were ever widening, and he was a clever man indeed who could claim to be an authority on any one of the sub-divisions of chemistry, dyes, drugs, even explosives, to take three sub-divisions which came to mind, and there were many others. Very few men would claim to be experts in all those things.

Well, that subject was being discussed a great deal in Enlgand to-day; but there was one conclusion to which most people had arrived, which might have an interest for South Africa, and he would mention it for what it was worth. So far as England was concerned, he was, he knew, on perfectly safe ground in stating it. It was this, that the teaching of the science of chemistry to-day had largely got into the hands of purely academic men without any industrial experience whatsoever; and that being so, the product turned out from the Colleges and Universities was very much of the same type and was rather difficult to fit into modern industrial conditions. He would leave that just at is was, only it had a wider implication, and he would just go beyond his subject for one moment to say that the same criticism was now being made against the engineers turned out by the Universities; they were far too much of the academic type. Fortunately, when those things had been studied and studied conscientiously and well, steps would be taken to put matters right, but, of course, that was a long and tedious process. But, so far as chemistry was concerned, he could say this positively, that the products of certain schools in the United Kingdom, where the professor or professors had had a considerable industrial training, were much more practical and able men than those who had had purely academic training, and invariably reached administrative and directorial posts quicker than did the others. Well, that was al lhe was going to say on the subject of the training of chemists. He was glad he had not been tempted to stray a little bit further, because he considered the next subject to which he was coming was much more interesting.

ECONOMIC POSITION OF SULPHURIC ACID.

Now one would think, at this time of day, that enough had been written about sulphuric acid to justify them in saying that finality had been reached. He was not, however, concerned that night with the relative merits of a great many processes which involved platinum or those which did not; he was rather concerned to-day with the economic aspect of sulphuric acid in so far as it affected international relationships, particularly within the Empire.

In England, during the War, the sulphuric acid plant was very nearly doubled to meet war exigencies. Since then a great deal of it had been scrapped; but the plant, as a whole, had a capacity of rather over one million tons of 70 per cent. acid per annum. It was working to-day at about 60 per cent. of its capacity. Therefore it was working uneconomically, the overheads being exactly the same as they would be if they were working to full capacity. Sulphuric acid being a basic chemical, other industries suffered through the high cost of sulphuric acid. Sulphuric acid in England was made either from pyrite, spent oxide—which was a gas works residual, as they would remember—or from imported American sulphur, which could now be obtained exceedingly cheaply. Those of them who dealt with the industrial side of chemical matters would probably remember an enquiry which was recently made, by a Committee of the Board of Trade, into an application for protection for the superphosphate industry in England. The superphosphate industry in England was suffering on account of the very fact he had referred to a moment ago; it was suffering because sulphuric acid was expensive to make, and, as sulphuric acid entered, as to one-half, into the composition of superphosphate, the superphosphate was expensive to make, and, therefore, expensive to sell to the farmer. The nett result of that

was that the farmer in England was paying considerably more for his superphosphate that he was willing to pay. Consequently, the foreigner, particularly the Belgian and the Dutch—the Belgian more so than the Dutch—was dumping both sulphuric acid and superphosphate into England.

With their permission he would just like to take them to the Continent for a few minutes, and show them how matters got so mixed up that it was sometimes very difficult to disentangle them.

For many years now Belgium and parts of Holland and Germany had been the home of the European zinc production. In Belgium one might say that the production of zinc was a national industry in every sense of the word. The procedure in the past was for the Belgian to buy his Broken Hill Concentrates, bring them to Belgium, where they would be discharged right alongside the zinc roasting furnaces, and, as all that ore had to be roasted, sulphuric acid came as a by-product. That sulphuric acid the Belgian used to make into superphosphate, as he had already indicated; and it was very largely that superphosphate that reached England, to the damage of superphosphate manufacturers there, and, very largely, the same superphosphate reached the South African market here, to the detriment of the local producers of superphosphate here.

All the sulphuric acid made in Belgium did not go to the manufacture of superphosphate. Even though there was a very considerable surplus that surplus went to the making of salt cake—sulphate of soda. Now they came up against another industry in Belgium—that of glass making. So they saw right away how these things were linked up together.

In the making of salt cake one made a great deal of hydrochloric acid, and, at all times, hydrochloric acid, unless it was consumed on the spot, was an exceedingly difficult and ticklish thing to handle; but it was used for de-tinning, for other minor operations, and for the making of gelatine—another national industry in Belgium. That gelatine was made in the following manner:—Bones—it might be human or animal bones, at any rate they were very old—were imported by the tens of thousands of tons from India and other parts of the British Empire. Those bones were treated with dilute hydrochloric acid, which dissolved out the phosphate. Some of this came back to South Africa as high-grade phosphate, and it was used at one time in Natal—he did not know whether it was to-day—for clarifying sugar syrup, for cattle lick, and other purposes. The residue contained the gelatine; they called it osein, a crude gelatine, and by subsequent processes of purification it made the table, photographic and all kinds of gelatine which were supplied all over the European markets. So that they would see, starting o ffwith the zinc, they had the zinc industry itself, the glass industry, the gelatine industry, and the superphosphate industry all closely linked up with one another. If losses were made in one department they could be made good in another.

THE PHYSICAL SOCIETY OF LONDON.

Proceedings at the meeting held on Friday, June 11, 1926, at the Imperial College of Science. Professor O. W. Richardson, M.A., D.Sc., F.R.S., President, in the Chair.

The Latent Heat of Fusion of Some Metals. By J. H. Awbery, B.A., B.Sc., and Ezer Griffiths, D.Sc.

Abstract.

The latent heats of a number of the commoner metals have been measured by determining the total heat of liquid and solid from a series of initial high temperatures.

The calorimetry was by the method of mixtures, introducing several refinements, of which the chief were the use of fairly large charges of metal (of the order of 2 kilograms), and a device by which the hot charge was not allowed in contact with the water of the calorimeter until the latter was completely closed; this eliminates error due to production and escape of steam, with a consequent loss of heat. The device referred to consisted in the provision of a sheet metal vessel suspended by threads from the main lid of the calorimeter. The aperture through which the charge was introduced was closed by a rotating lid, in the main lid, and the crucible being introduced, was submerged after the closing of this smaller lid by means of a wire passing through an eyelet in the base of the calorimeter, and out at the top.

The paper also contains values for the specific heats up to the melting point, obtained by differentiation of the temperature-total-heat curves.

The Piezo-Electric Quartz Resonator and its Equivalent Electrical Circuit. By D. W. DYE, B.Sc., National Physical Laboratory.

ABSTRACT.

The quartz piezo-electric resonator is examined experimentally and theoretically with special regard to an equivalent electrical system which can represent it.

It is shown that, as theoretically predicted by Butterworth, such a resonator can be represented by an inductance, a resistance and a capacity all in series. These are pictured as in parallel with another small condenser, and the whole is in series with a third condenser, the additional condensers representing air-gaps. The equations for the current in an oscillatory circuit, to which the resonator is attached, are developed and it is found that almost perfect agreement exists between the forms of current curve obtained theoretically and experimentaly. This agreement is found to hold for longitudinal resonators of as low a frequency as 44,000 and for transverse resonators of as high a frequency as 15,000,000 periods a second.

It is next shown how the logarithmic decrement of the resonator may be obtained from a rectified line plotted from observation on the current in the oscillatory circuit as a function of frequency width across the crevasse which pierces the summit of the resonance curve.

The methods of analysis of the equivalent mesh into its components are next developed and it is shown that this analysis can be effected by carrying out a series of observations of the current at resonance when the air-gaps are varied by known amounts, or when the effective resistance of the oscillatory electrical circuit is given different known values.

The theoretical and experimental results are found to be consistent. The value of the shunting condenser is somewhat smaller than that measured at a neighbourng frequency outside the region or resonance. A possible explanation is offered.

The effects on frequency of response of variation of air-gap are studied and the difference between prediction and observation is discussed. This difference is only a few parts in a hundred thousand. In the case of transverse resonators remarkable effects occur when the air-gap is varied through the regions where its length is an integral member of half-wavelengths of the supersonic air waves produced by the vibration of the quartz.

The temperature coefficient of frequency of a considerable variety of resonators is examined over a range of temperatures up to 40° C. It is found that very diverse results are obtained and probable explanations are offered.

The effects of displacement of the resonator from the position of centrality are examined. These are shown to be small, but not quite negligible.

The current taken by the quartz mesh is then examined in some detail theoretically, and one or two experimental curves are given, together with a graphical method of deducing the cure of current from the constants of the quart. A selection of theoretical curves for the conditions under which the experiments of Cady were made have been calculated. The curves are in all respects of the shape and form experimentally found by him.

A number of conclusions and suggestions terminate the paper.

NOTICES OF BOOKS.

Braunkohle und Ihre Chemische Verwertung. Von DR. A. FURTH. Pp. 135. Dresden and Leipzig: Theodor Steinkopff, 1926. Price, 7 marks.

The coal industry has been in the forefront of almost everyone's thoughts for some months, particularly since the lock-out commenced nearly two months ago. With the political aspects of the present dispute we are not concerned ,hut it seems as though at last it will be recognised that more scientific methods must be introduced into working practice in order to bring British mining up to the general level of progressive continental countries. The results which can be claimed to accrue from the adoption of scientific methods would obviate the case for asking the miner to remain underground for eight hours a day or to accept a lower wage.

In Germany the coal is of a poorer quality than that obtained from British mines, yet by introducing highly scientific methods the

Germans have reached a high state of perfection, not only in extracting the coal from the earth, but also in converting it into valuable chemical products. The distillation of brown coal and the working up of the fractions has received close attention. Increased monetary returns have succeeded the adoption of methods and procedures dictated by the results of scientific research. Refining processes are so arranged that purified products are comparatively readily obtained and all "waste" is worked up in some form or another. In this manner everything is done to lessen the cost and price of the main commodities, thus facilitating other industrial developments.

All this, and much more in detail, can be inferred by a study of Dr. Furth's book in Steinkopff's valuable series of technical publications produced under the editorship of Dr. Rassow. The author has apparently studied the Patent literature very carefully—a matter of some importance so far as this subject is concerned.

J. G. F. D.

Die Pektinstoffe. Von Dr. R. Sucharipa. Pp 188. Brunswick: Dr. Serger & Hempel. 1925. Price, 6 marks.

Among the complex naturally occurring organic bodies whose composition has not yet been completely elucidated are the pectins or jelly-forming substances in fruits. They were discovered in 1824 by Braconnot and since then have been the subject of numerous investigations, notably by Fremy, Scheibler, and more recently Tschirch, von Fellenberg, Ehrlich, Haynes, Tutin and others. The pectins have also attracted the attention of botanists and have assumed importance in the brewing and canning industries.

The early work served to show that the pectins are carbohydrate derivatives possessing acidic properties. Fellenberg and Ehrlich showed that they contained methyl ester groups and galactose together with galacturonic acid, which is an intermediate oxidation product between galactose and mucic acid. Metals, *e.g.*, iron, may also be present, although it is now apparent that pectin is not the calcium-magnesium salt of a complex carbohydrate acid as Ehrlich supposed. The formula proposed by Fellenberg is

$$(C_5H_8O_4)_2.(C_6H_{10}O_5)_2.(C_5H_7O_4\text{-}COOCH_3)_8.2H_2O.$$

but it should be remembered that there are *at least three distinct pectin bodies—protopectin, occurring in roots, e.g., beet, and unripe fruits; soluble pectin, in ripe fruits; and pectic acid, in over-ripe fruits and in vegetables.* The author mentions no less than seven distinct and characteristic varieties.

In the examination of these complex substances a special technique is acquired by the investigators, but the exact nature of the substances is still by no means thoroughly understood. The author has collected together the main facts and has summarised the work (including patents) that has been done on these bodies and has presented it in a manner accessible to the general reader as well as the specialist. This is the first book devoted to the pectins and its importance cannot be over-stated in view of the rapid development in the canning trade, especially in America. It is reasonable to expect the early appearance of an English version of this work.

Vacuum Practice. By L. Dumoyeer (Maître de Conférences a la Sarbonne, Paris). Translated by J. H. Smith, M.Sc., Lecturer in Physics, University College, London. X + 228 pp. Price 12s. 6d. London: G. Bell & Sons, Ltd., York House, Portugal Street.

This is a well-written book, and it was a happy suggestion of Professor Andrade that an English translation should be made. True, there are other English works on the same subject, but there is ample room for this work, especially when so carefully translated as this has been done by Mr. Smith. Particular attention has been paid to the practical as opposed to the theoretical, but this will be generally considered a good feature, especially in a work that is too short to completely cover the subject in detail. The work is well illustrated, contains an extensive bibliography, and a useful index.

The Kinetics of Chemical Change in Gaseous Systems. By C. N. Hinshelwood, M.A., Fellow of Trinity College, Oxford. Pp. 204. Price 12s. net. Oxford: At the Clarendon Press.

This work is based on lectures given in Oxford, and is, we are told, due to the interest manifested in the said lectures by many undergraduates with whom the author worked in this branch of Physical Chemistry. Not the least important part of the book is the exhaustive introduction,

extending to some 88 pages, in which are given many useful formulæ. Then follow chapters on Bimolecular Reactions, The Energy of Activation, Termolecular Reactions, Unimolecular Reactions, The Kinetics and Activation of Heterogeneous Reactions. There is an index of authors, and of subjects in alphabetical order.

J. G. F. D.

RESEARCH IN BREWING INDUSTRY.

The Institute of Brewing has just issued the fifth report of the Research Committee covering the work done during the last two years. Investigations of national importance have been carried out in connection with the improvement of hops, the keeping properties of yeasts and on various hydrogen ion concentration experiments. Close co-operation between brewers, farmers, and biological chemists has enabled important results to be obtained and douhtless the future will see still greater achievements in solving the problems facing the industry.

ON THE MODULI OF ELASTICITY AND RIGIDITY, AND THEIR CHANGE CAUSED BY MAGNETISATION, IN DIFFERENT KINDS OF STEEL.

By Kôtarô Honda and Tomoichi Tanaka.
(*Science Reports, Tohoku Imperial University, Sendai.*)

Apparatus of Measurement.

The present investigation consisted of the measurement of the moduli of elasticity and rigidity for different kinds of steel, such as carbon, nickel and cobalt steels, and that of their change by magnetisation. The absolute measurement of the moduli themselves was made by the usual methods of bending and of twisting as constantly used in our laboratory. The specimens were tested in the form of cylindrical rods, 20 cm long and 5 mm thick.

THE MOTION OF ELECTRONS IN HYDROGEN AND HELIUM.

By H. B. Wahlin.
(*U.S.A. Physical Review.*)

Abstract.

Mobilities of electrons in H_2 and He at 760 mm pressure have been measured by the Rutherford alternating potential method for fields ranging from 0.5 to 46 volts/cm. The limiting mobilities for zero field are calculated to be, for H_2, 6,700 cm/sec. per volt/cm and for He, 10,840 cm/sec per volt/cm.

Energy loss of an electron on impact in H_2 and He.—*K. T. Compton's theory of electronic mobilities* is shown to fit the observed variation of mobility with field strength provided it be assumed that the fraction of its energy an electron loses on impact is, in H_2, 2.16, and in He, 8.6 times what it would be were the collisions elastic.

Mean free path of electrons in H_2 and He.—From the limiting values of the mobilities at zero field it is calculated that the *mean free path of electrons in thermal* equilibrium with the gas is for H_2 at 1 mm pressure, 0.0408 cm, and for He at 1 mm pressure, 0.066 cm. These values are approximately half the kinetic theory values.

ROYAL INSTITUTION.

A General Meeting of the Members of the Royal Institution was held on Monday afternoon, July 5, Sir Arthur Keith, M.D., LL.D., F.R.S., Treasurer and Vice-President, in the Chair. Colonel Belaiew was elected a Member.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

15,188.—Adam, M. A.—Detinning tinned iron scrap, etc. June 16th.

14,959.—Speichert, M.—Process for treating lead-tin alloys. June 14th.

14,936.—I. G. Farbenindustrie Akt.-Ges.—Manufacture of dry preparations containing formaldehyde. June 14th.

14,937.—I. G. Farbenindustrie Akt.-Ges.—Manufacture of acidyl cellulose. June 14th.

15,398.—I. G. Farbenindustrie Akt.-Ges.—Manufacture of paraformaldehyde. June 18th.

Specifications Published.

232,230.—Farbwerke Vorm. Meister, Lucius and Bruning.—Manufacture of indigoid dyestuffs containing sulphur.

244,774.—Heffner, L. W., and Tiddy, W.—Treatment of gas liquor and other waste liquors for the separation and recovery of phenol therefrom.

Printed Copies of the full Published Specification may be obtained from the Patent Office, 25 ,Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

Abstract Published.

250,883.—Anthraquinone derivatives. —British Dyestuffs Corporation, Ltd., 70, Spring Gardens, Bunbury, H. M., Crumpsall Vale Chemical Works, Blackley, and Robinson, R., The University, all in Manchester.

*Mono-oxalyldiamino*anthraquinones are obtained by heating diaminoanthraquinones with oxalic acid and water at 105-110° C. As parent materials are specified 1 : 4-, 1 : 5, and 1 :8-diaminoanthraquinones, and diaminoanthrarufin. The mono-oxamic acids yield ammonium, sodium, barium, etc., salts, and the oxalyl group is readily hydrolysed off by alkalies or strong mineral acids. On heating to 180-190° C. the oxamic acids lose carbon dioxide and yield monoformyl derivatives; they may be analysed by measuring the carbon dioxide split off in this way.

The Latest TRADE MARKS

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JUDEX.

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ROTOSAN.

460,036.—Chemical substances used for agricultural, horticultural, veterinary and sanitary purposes.— W. & F. Walker, Ltd., Colonial House, Water Street, Liverpool. June 23rd.

469,866.—Chemical substances prepared for use in medicine and pharmacy.—Harpic Manufacturing Co., Ltd., 2 to 14, Staple Street, London, S.E.1. June 23rd.

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A COMPACT AND COMPREHENSIVE SERIES OF REACTIONS AND TABLES IN CHEMISTRY.

By ROBERT SAXON, B.Sc., F.C.S.

(*Continued from Page 395, Vol. 132.*)

SOLUBILITIES OF THE HALOIDS.

HF : :, HCl : :, HBr : :, HI : : :, NH_4F : :, NH_4Cl : :, NH_4Br : :, NH_4I : :, NH_4Br_3x :, NH_4I_2, NH_4I_3 :, N_2H_42HF :, N_2H_4HCl : :, N_2H_42HCl :, N_2H_4HBr :, N_2H_42HBr :, N_2H_4HBr : :, : N_2H_4HI :, :N_2H_42HI :, $NH_3(OH)Cl$:.

LiF ! !	BeF_2 : :	BF_3	CCl_4	NF_3xxxx	None	F_2
$LiHF_2$!	:$BeCl_2$: :	BCl_3	CBr_4	NCl_3xxxx	OCl_2 :	hyd.
:$LiCl$: :	$BeBr_2$: :	BBr_3	CF_4	NBr_3xxx	O_2Cl	No chl.
:$LiBr$: :.	BeI_2 :	BI_3	CI_4	NI_3xxx	! ! !	F_3Br
:LiI : : :	All hyd.	All : but	C_2Cl_4	NH_2Ixxx	O_2Cl_2	hyd.
		hydrolyse	C_2Cl_6	NHI_2xxx	hyd.	F_5I
		All other salts	C_2Cl_2	All hyd.	No. bro.	hyd .
		hyd.	etc. all		O_2I_2 : :	
			hydrolyse			

NaF :	MgF_2 ! ! !	AlF_3 ! ! !	SiF_4 : : :	PF_3	SF_6 !	No flu.
$NaHF_2$:	$MfCl_2$: :	: $AlCl_3$: :	$SiCl_4$	PF_5	S_2Cl_2	Cl_2 ! !
Na_4Cl_2	$MgBr_2$: : :	hydr.	$SiBr_4$	PCl_3	SCl_2	Cl_3I
hydrol.	MgI_2 : : :	: $AlBr_3$: :	SiI_4	PCl_5	SCl_4	ClI
$NaCl$: :		:AlL_3 : :	SiH_2F_6	PBr_3	S_2Br_2	hydro.
$NaBr$: : :		All hyd.	$SiHCl_3$	PBr_5	SBr_2	
NaI : : :			$SiHBr_3$	P_4I	SBr_4	
			$SiHI_3$	P_2I_4	S_2I_2	
			Si_2Cl_6	PI_3	SI_6	
			Si_2Br_6	PI_5 ?	All hyd.	
			Si_2I_6	P_2Cl_4		
			All hyd.	All hyd.		

KF : :	CaF_2 ! ! !	ScF_3 ! ! !	TiF_4 :	VF_3 : :	CrF_2 !	MnF_2 ! ! !
KHF_2 : :	CaH_2F_4 ! ! !	$ScCl_3$	: $TiCl_4$	VF_4 : :	Cr_2F_6 !	Mn_2F_6 : :
KCl : :	$CaCl_2$: :	$ScBr_3$	: $TiBr_4$	VF_5 : :	CrF_6hyd.	$MnCl_2$: :
KBr : :	: $CaBr_2$: : :	ScI_3 ?	: TiI_4	: VCl_3.	: $CrCl_2$:	Mn_2Cl_6 :
KI : : :	CaI_2 : : :	All hyd.	Ti_2F_6	VCl_4 :	Cr_2Cl_6	: $MnBr_2$:
: KI_3 : :			: Ti_2Cl_6	hyd.	! ! !	Mn_2Br_6
KCl_2I			: Ti_2Br_6	VBr_3 :	: $CrBr_2$:	: MnI_2 :
				hyd.		
$KBrI$			: Ti_2I_6 :	: VI_3 :	: CrI_2 :	
both xx			: $TiCl_2$:	V_2O_2Cl ! ! !		
			All hyd.	$VoCl$! ! !		
				VOF_2 ! ! !		
				$VOCl_2$ hyd		

	No fluorides of the first two				PdF_2 ! !	
uCl_2 :	: $RuCl_3$:	$RuCl_4$:	$RhCl_2$! ! !	$RhCl_3$! ! !	: $PdCl$:	$PdCl_2$: :
	$RuBr_3$:			$RhBr_3$!	not	known
	RuI_3 ! ! ! ?			RhI_3		PdI_2 ! ! !
	OsF_4 :			No fluoride	PtF_2 ? ! ! !	
	OsF_6 hyd			$IrCl$! ! !	: PtF_4 : hyd	
	OsF_8 hyd			$IrCl_2$! ! !	$PtCl_2$! ! !	
	: $OsCl_2$: hyd			$IrCl_3$! ! !	$PtCl_3$!	
	$OsCl_3$:			$IrBr_3$: :	$PtCl_4$: :	
	$OsCl_4$:. hyd			: $IrCl_4$: :	$PtBr_2$! ! !	
	OsI_4xx ! ! !			$IrBr_4$: :	$PtBr_4$!	
				IrI_3 !	PtI_2 ! ! !	
				IrI_4 ! ! !	PtI_4 ! ! !	
					$PtCl_2I_2$! ! !	
					$PtCl_3I$! ! !	

Just as we have the stratum Fe, Co, Ni, Cu, with drop of valency from Fe to u, and insolubility in the monad salts of copper, so have we a marked drop from s to Pt and Au, with insolubility of the lowest valency salts the fluoride, chloride, romide, and iodide of divalent platinum. The Ru stratum shows the same drop in alency especially if we consider Ag as the last member. It does not show the array f haloids as the Os stratum, but they are more stable. It should be noted that the aloids of Fe, Ru, and Os, are more prone to hydrolysis than those of Ni, Pd, or Pt, hus showing greater preference for oxygen than the last over chlorine. It should e noted that valency mounts greatly as we descend the group the lowest three nembers showing themselves as tetrad, hexad, and even octad in osmium salts. It nay be that the formulæ of the lower valency salts is not so simple as here shown, ut that the metal nickel, palladium, or platinum forms a ring in its compounds like arbon. Like carbon they are not eager to unfold themselves to take on new ssociates.

THE PROBLEM OF CORROSION.

What British Chemists Are Doing to Solve It.

Among the exceedingly interesting items which are to be dealt with at the Congress of Chemists and the forty fifth Annual Meeting of the Society of Chemical Industry to be held in London in July, a session of outstanding interest will be that on Tuesday July 20, when a symposium is to be held, dealing with the subject of "Corrosion." In view of the fact that this symposium is a joint meeting of the British Chemical Plant Manufacturers' Association, the Institute of Metals, the Institution of Chemical Engineers, and the Chemical Engineering Group, it cannot fail to be of vital interest to the chemical industries. The costly effects of corrosion in every branch of engineering, and especially in chemical and gas works, are known to every constructional engineer and works manager, and if the chemist and metallurgist, between them, can remove them, they will be conferring a lasting benefit on British Industry.

What British research has already done and is still attempting to do will be explained by a group of recognised authorities, including Mr. Ulick R. Evans, who will deal with "The Fundamental Principles of Corrosion," Mr. P. Parrish, who will speak on "Corrosion and Erosion," and Dr. W. H. Hatfield and Messrs. T. G. Elliott and G. B. Willey, who will discuss "Chemically Resistant Steels." It will be obvious that the problem is being attacked by men of considerable experience in the subjects involved, and this symposium will be of outstanding interest to chemists, chemical engineers and the industry generally.

Possibly in no branch of metallurgy has there been such great advancement, both during and since the war years, as in connection with the production of chemical resistant steels and acid resisting irons. The introduction of novel methods of manufacture and the alloy of some of the newer and less common metals with iron and steel have produced alloys of a chemical resist

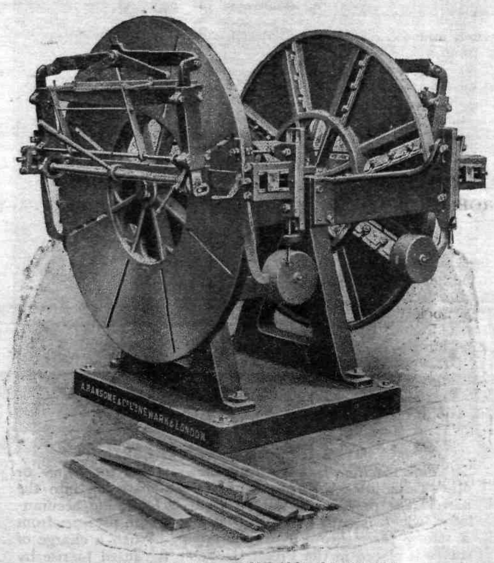
(*Continued on Page 40*)

Prominent Engineering Industries.

CASK MAKING MACHINERY FOR ALL PURPOSES

Messrs. A. RANSOME & CO., Ltd., Newark-on-Trent and London.

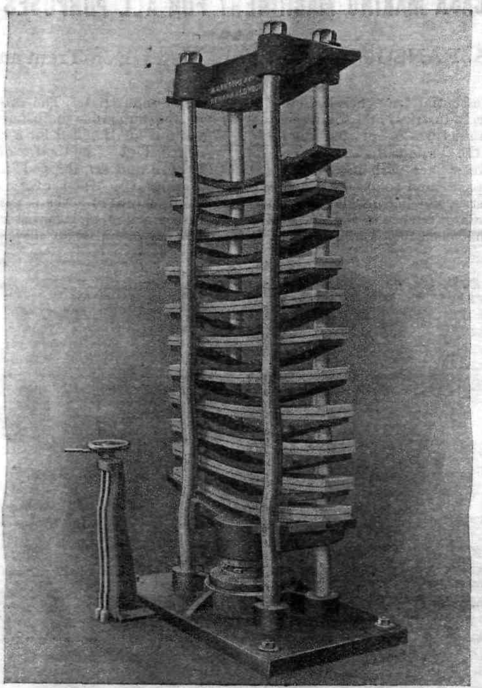
Casks are essential in chemical and numerous other Industries, and their cheap and rapid manufacture is of paramount importance if the various industries concerned are to keep pace with modern progress. In the past hand-coopering was an important industry, but had to give way to the onward march of science in the shape of machinery, as has been the case in so many other industries. The proper development of the numerous industries using casks of various kinds called for a cheaper and more expeditious method of manufacture. Science and art stepped in and provided machines by which every operation in the manufacture of casks is performed not only at a fraction of the cost entailed by hand labour, but also far more efficiently.



DISC STAVE JOINTING MACHINE.

The machines, of which the above is a type, are the best for all cylinder sawn staves. The joints are formed by a series of plane irons which project slightly through the face of a large iron disc, driven at a high speed.

One of the leading engineers manufacturing this machinery are Messrs. A. *Ransome and Co., Ltd., of Stanley Works,* Newark-on-Trent (England), and 63, Queen Victoria Street, London, E.C.4., who have favoured us with a copy of their beautiful illustrated catalogue. This company enjoys a well-merited high reputation for the excellence of its machinery, which has been supplied to many of the leading chemical

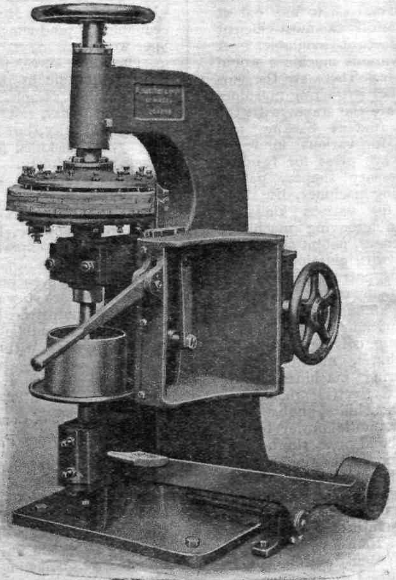


HYDRAULIC STAVE PRESS.

This machine is used for bending staves for wine or other casks into the form requred when made up into the barrel. The presses are worked from a hydraulic accumulator, which is supplied with water at a high pressure from a strong three-throw hydraulic pump. When a charge of staves is placed in the Press, the table is caused to rise by opening the cock communicating with the accumulator, and when the staves have been pressed into the required shape, the cock is shut, and the staves are allowed to cool in the Press, when they will have received a permanent set. The Presses can be made for belt-drive as well as hydraulic power.

firms at home and abroad. Among them may be mentioned the British Dyestuffs Corporation, Messrs. Brunner Mond and Co., Ltd., Chance and Hunt, ltd. (Oldbury), Castner Kellner Alkali Co., Ltd., Runcorn and elsewhere, Electro Bleach and By-Products, Ltd., Middlewich, Orr's Zinc White, Ltd., Widnes, The United Alkali Co., Ltd., Liverpool, etc., and numerous breweries, paint, white lead and cement, provision and many other firms. The many testimonials which the Company publish shews the appreciation of the customers.

The following are some of the purposes for which casks and barrels are made by the machinery supplied by Messrs. Ransome—Soda, alkali, cement, vinegar, chemicals of all sorts, liqueurs, white lead, fish, butter, soaps, gunpowder, fruit, beer, wines, palm oil, molasses—and one could continue the list almost *ad infinitum*. It will thus be seen what a large part cooperage machinery plays in the industry of the country. It is no wonder that there was an insistent call for machinery to replace the slow and expensive hand methods of the past. The demand was not only in Great Britain, but all over the world. To adequately meet



HEAD ROUNDING MACHINE.

This machine is used for rounding heads, the edges of which do not require to be bevelled. The cutter is carried in a vertical slide, and is brought up by depressing the hand lever shewn in the machine. One lad working this machine will turn the heads of about 700 barrels in eight hours. The machines are made in various sizes.

the want, several conditions had to be fulfilled by the machinery introduced, among which might be mentioned : *Economy*—The machinery must effect economy in labour and cost. *Efficiency*—The work produced must be equal at least to the hand-made cask or barrel. *Simplicity*—The machines must be so simple that they can be operated by semi-skilled or unskilled labour.

These essentials have been amply fulfilled by the machines employed in the various operations necessary to convert the logs into the complete cask or barrel. Modern competition demands cheapness and rapidity of production, and any firm that uses casks and barrels to any extent must meet competition by the most efficient methods of manufacture available. A description of the various machines would fill considerable space. There are the various circular and other self-acting machines which cut and prepare the staves with the minutest precision, patent backing and hollowing machines for various kinds of staves, hydraulic stave press for bending staves into the necessary shapes, patent universal stave jointing machines, disc stave jointing machines for various kinds of staves, touguing and grooving machines, steaming and firing cones, patent stave drying oven, combined with chiming, crozing and printing machines, patent barrel raising machines, setting up apparatus, hydraulic trussing machines, chiming, crozing and howelling machines, cleaning-off machines, patent hydraulic hoop driving machines, head rounding machines, multiple hoop punching and shearing machines, hoop splaying, bending and rivetting machines, wood hoop bending machines, bung hole boring machines, automatic power barrel hoist, circular and band saw sharpening machines in connection with the barrel-making industry. These are some of the principal machines.

In the manufacture of barrels, etc., there are produced large quantities of dust and shavings, and Messrs. Ransome have produced an ingenious patent cyclone dust collector, which obviates this nuisance.

The general keynote of the testimonials from users of the machines is *economy*, comprised in saving in loss in manufacture, economy of labour, simplicity of operation, equality of work, low cost of maintenance.

The following will shew the great output capacity of the machines :—

The cross-cut saw for headings will, worked by a lad, cross-cut enough heading for from 2,000 to 4,000 casks per day.

One of the cylinder stave saws will dispose of up to 4,000 staves per day.

The backing and hollowing machine, with automatic feed, for cylinder or straight-sawn staves, will deal with from 20 to 50 staves per minute according to their length.

The saw stave jointer has a production capacity of up to 1,700 hogshead staves in eight hours, while the universal stave jointing machine has a great capacity; those supplied to Thames and Medway Cement Manufacturers by Messrs. Ransome being capable of producing over 100,000 barrels per week.

The disc stave jointing machines are equally prolific in their output capacity.

These few samples are typical of the other machines, not only in their large output capacity, but in their simplicity and safety, an unskilled lad being able to work them satisfactorily.

Quite recently a large plant for making tar barrels has been supplied to the Agwi Petroleum Corporation, Ltd., of Fawley.

Messrs. Ransome, Ltd. (whose catalogue is stated by an expert to be the most complete treatise on the cooperage industry that has ever been published) are doing an important work towards the development of various industries by placing before the manufacturing public the means of successfully competing with rivals in the world market.

The Problem of Corrosion — *Continued from Page* 36.

ance quite unprecedented and the steels which are to-day being produced to withstand corrosion are far in advance of the earlier forms of stainless steel, which are chiefly martensitic. The newer corrosion-resisting steels are austenitic, *i.e.*, they are softened by quenching from a high temperature, as in the case of manganese steel, whilst the acid-resisting irons have been also greatly improved recently, both from the point of view of homogenity and toughness, resultant upon careful methods of heat treatment. Experts are looking for some very useful surprises for many industrialists, as a result of this Congress.

General Notes.

SCOPE OF ENGINEERING WORK.

(*Samuel Rea, D.Sc., LL.D., in the Journal of the Franklin Institute.*)

The profession of Engineering, in its broadest scope, is the practical application of scientific progress in the utilisation of natural resources, forces and laws on behalf of human advancement. Technical knowledge is only his groundwork. Ultimately he is concerned with its economic and social values and adaptability.

Perhaps the best definition of civil engineering is that written more than 100 years ago by Thomas Telford, first President of the Institution of Civil Engineers of Great Britain, in which I have been accorded the honour of membership since 1891. Telford declared it to be "the are of directing the great sources of power in Nature for the use and convenience of man." He further elaborated upon this definition hy describing some of these uses, naming amoug them the means of production and traffic, the constrnction of roads, bridges, aqueducts, canals, docks, ports, moles, breakwaters, and lighthouses, the use of artificial power in commerce, the construction and adaption of machinery, and the drainage of cities and towns.

RAYON PLANT FOR NOVA SCOTIA.

A plant designed for the manufacture of artificial silk underwear from the forests of Nova Scotia has just been erected at Truro, at a cost of approximately $400,000. Already the company has more orders on hand than they can fill. The firm has also been given a patent on a special process for combing artificial silk and wool.

MAGNESIUM SULPHATE IN BRITISH COLUMBIA.

The Mines Branch of the Dominion Department of Mines has just published in its summary report for 1924 two reports by Mr. M. F. Goudge dealing respectively with "Magnesium Sulphate in British Columbia," and with "Sodium Carbonate in British Columbia," copies of which could be obtained on application to the Natural Resources and Industrial Information Branch, The Canadian Building, Trafalgar Square, London, S.W.1.

OIL SHALES OF NOVA SCOTIA TO BE DEVELOPED.

Oil and Nitrate Products, Ltd., a Nova Scotia corporation, has recently completed negotiations with Messrs. H. L. Doherty and Co., and the Cities Service Company of New York, whereby a far-reaching system for the development and production of oil and other products of the Pictou County oil shales is to be undertaken.

REVERSIBLE PERMEABILITY OF MEMBRANES AND ITS RELATION TO CELL METABOLISM.

By Charles Gurchot.

(From the *Journal of Physical Chemistry*.)

It is well-known that a living cell removed from its parent organism can be kept alive in the proper liquid medium. If, instead of a single cell, a community of cells or a piece of tissue is kept in a nutritive liquid, the tissue not only will be preserved, but it will grow and proliferate. In other words, in its own small way, it behaves more or less as a complete organism as long as the medium remains constant and as long as the tissue remains the same at it was at the start. But the isolated cell behaves differently. Its isolation is tantamount to a physieal divorce in addition to an anatomical one for the cell appears to be permanently at rest and in this condition it is impermeable for almost everything which it ordinarily uses for food and to the products of its metabolism which are formed in the interior of the cell "from the undissolved carbohydrate reserves, and also for inorganic salts and salts of organic acids." Naturally the cell cannot behave in this way when still a part of the original organism. Another significant phenomenon takes place after death. Then the cell behaves as an ordinary membrane which retains colloids only.

It seems fairly well established, now, that the cell is surrounded by a pellicle which functions as a semi-permeable membrane. Deductions from the second law of thermodynamics embodied in Willard Gibbs' principle show that all substances present in the cell and which lower its surface tension must concentrate at the periphery. that is at the interface between the cell contents and the surrounding medium. It has been shown that the concentration of some bile salts may exceed the solubility.

Such substances will be deposited then as solid films enclosing the cell. One is forced to ask whether something does not take place in the mass of tissue which alters the permeability of the cell through something which is either stored or produced in cells *en masse*. Unfortunately, it is impossible at the present time to exact an equivocal answer to this question from the cell directly, for the simple reason that the composition of cell membranes is not known. Yet previous considerations suggest that we ought to find in the membrane substances which lower the surface tension of water considerably. Such are the fatty compounds. Nor is it known what makes the membrane semi-permeable, let alone how the permeability is altered.

SUMMARY.

1. Copper ferrocyanide membranes are coagulated by low concentrations of methyl alcohol, acetic acid, sodium chloride, potassium chloride and calcium chloride, thereby becoming permeable to sugar.
2. A copper ferrocyanide sol is flocculated by aqueous alcohol, whereas alkalies and water peptize a copper ferrocyanide gel.
3. The coagulation of copper ferrocyanide is caused by selective adsorption rather than by decrease in surface tension.
4. Copper ferrocyanide forms a granular membrane between those particles adsorbed water is present which fills the spaces more or less completely.
5. Coper ferrocyanide membranes are coagulated by water at a temperature of about 24° C.
6. The coagulation of copper ferrocyanide is reversible.
7. Bartlow's experiments with alcohol, Walden's experiments with acids, and Czapek's experiments with alcohols and acids involved nothing more mysterious than a coagulation of the membrane.
8. Intermittent permeability in living membranes is probably also a question of reversible coagulation.

RECENT MINERAL DISCOVERIES IN WEST QUEBEC.

Among the papers prepared for the March Annual General Meeting at Montreal of the Canadian Institute of Mining and Metallurgy, was one by Mr. A. O. Dufresne, Mining Engineer to the Quebec Bureau of Mines, dealing with the "Recent Mineral Discoveries in Western Quebec," and one by Dr. H. C. Cooke of the Dominion Geological Survey, dealing with "Recent Developments in North-Western Quebec."

Copies of these papers can be consulted at the Natural Resources and Industrial Information Bureau, The Canadian Building, Trafalgar Square, London, S.W.1.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

June 24, 1926.

Researches on the Mode of Distribution of the Constants of Samples taken at Random from a Bivariate Normal Population. By KARL PEARSON, F.R.S.

This paper deals with the distribution in samples—regardless of their size—taken from a large normal population of some of their "compound" constants. By compound constants, the author understands not simple constants like means, standard deviations, or coefficients of correlation, but functions of these constants. In the present paper the actual curves of distribution of the standard deviations of arrays, and of the regression coefficient are obtained. Also the distribution of the means of arrays as determined by the regression line of the sample is studied, and all the moments of this distribution are determined, but thus far it has not been possible to determine its curve of distribution, which depends upon the definite integral

$$\int_{-\frac{1}{2}\pi}^{\frac{1}{2}\pi} e - (a \cos \theta - b \sin \theta)_2 \cos \theta \, l)$$

which has so far not been obtained except by expansion in a double series of terms.

A noteworthy fact is that even when sampling from a normal population the curves of distribution of compound constants (like those of the majority of simple constants) are not themselves normal, nor are the relations between them linear. It follows accordingly that the so-called "probable errors" of these constants are of relatively small significance in exactness, especiall in the case of *small* samples, where

their values are usually given by physicists and astronomers, as measures of accuracy of observation.

Further Spectroscopic Studies on the Luminous Vapour Distilled from Metallic Arcs. By LORD RAYLEIGH, F.R.S.

In this paper observations are described on the jets of luminous vapour distilled from metallic arcs, further to those in *Roy. Soc. Proc.*, A., vol. 108, p. 262, 1905.

It is shown that the appearance of high series members in the luminous vapour is due to their narrowness. In the arc these lines are so broad as to overlap one another. As the vapour emerges and expands, they become narrow and can be resolved.

Enhanced lines occur in the distilled vapour though in diminished intensity relative to the arc lines. In some cases, *e.g.*, magnesium, they fade out very rapidly compared with the arc lines.

The resonance line of mercury $1_1S'$—$1\ p_2$ gains intensity relative to all other lines as the vapour matures. The same is true of calcium; but the corresponding line of magnesium behaves in the opposite manner, dying out more quickly than the series lines in general.

A luminous jet of one metallic vapour is able in many cases to excite the vapour of another metal injected into it. As a rule such excitation does not take place unless the ionisation potential of the first metal exceeds the excitation potential of the spectrum line in question. There are, however, some exceptions to this rule, and possible explanations are discussed.

The More Refrangible Band System of Cyanogen as Developed in Active Nitrogen. By W. JEVONS. Communicated by Prof. A. Fowler, F.R.S.

Rayleigh and Fowler described certain modifications in the λ4216 ($n'' - n' = +1$) and λ3883 ($n' - n'' = 0$) groups of CN bands developed in the afterglow of active nitrogen as compared with the arc. Modifications of the λ3590 ($n'' - n' = -1$) group and of some of the "tail" bands are discussed. By means of Heurlinger's and Kratzer's formulæ, and the combination principle, data for the (1, 0) and 2, 1) bands of the λ3590 group are identified in Kayser and Runge's arc list.

The modification in the λ4216 and λ3883 groups and the interpretations of them given by Birge and Mulliken, are discussed with the aid of grating measures. The afterglow develops especially lines of low m values and bands of high n' values. As n' increases the intensities of the band in each group tend to show an alternation as well as a general increase. Bands with $n' = 1$ are the weakest.

The λ3590 group (like the above) is shortened in the low-λ direction, but (unlike the above) it is prolonged in the high-λ direction in the afterglow as compared with the arc, and also consists of headless bands. It is shown that on the assumption that these bands have $n'' - n' = -1$, the absence of heads follows from the non-development of high-m lines, and the high-λ extension is in accordance with the enhancement of high-n' bands.

MINERALOGICAL SOCIETY.

The following papers were read at the meeting held on June 15, Prof. H. Hilton, Vice-President, in the chair :—

On Some Chloritic Minerals Associated with the Basaltic Carboniferous Rocks of Derbyshire. By S. I. TOMKEIEFF.

In this paper the author has described certain leptochlorites occurring yas vesicular infillings in the Carboniferous lavas ("toadstones") of the North Derbyshire area. The chemical analysis of a finely spherulitic chlorite from Calton Hill places it definitely in the delessite-diabantite series. Some other chlorites from Miller's Dale are less crystalline and show a peculiar deveopment of bacteria-like aggregates, similar to those observed in the chloropacite of Dalmahoy Hill, near Edinburgh. All these chlorites can be compared with the chloritic palagonits occurring in the mesosasis of the non-vesicnlar basalt of the same lava flow, and it is suggested that both varieties of chlorite are primary, and were formed during the final stages of the solidification of the magma (autopneumatolitic).

On the Nature of Berthierite. By DR. F. L. STILLWELL.

A chemical analysis of berthierite from Nullamanna, near Inverell, New South Wales, gave the formula $3FeS.4Sb_2S_3$. Microscopical examination of polished and etched sections of the material shows an intergrowth of about 18 per cent. of stibnite. Deducting this from the results of the chemical analysis, the formula of berthierite becomes $FeS.Sb_2S_3$.

A Sperrylite crystal from the Transvaal. By Dr. L. J. Spencer.

Crystals of sperrylite (the rare platinum arsenide, $PtAs_2$) up to half-an-inch across have recently been found in the Potgietersrust platinum fields, Transvaal. The crystal examined measures 5.0 to 5.5 mm. across and weights 1·.294 bram. It is a brilliant cubo-octahedron developed on all sides and with the corners and edges much rounded. The rounded areas give a profusion of scattered reflected images, few of which lie in the principal zones on the crystal. The only forms identified with certainty are (100), (111), (110), (210), 2(11).

The Anomalous Optical Properties of Some New Series of Isomorphous Double Tartrates. By H. E. Buckley.

In addition to the mixed crystals [m NaK, n $Na(NH_4)$] $C_4H_4O_6.4H_2O$ previously examined, optical anomalies of the same kind have now been determined for the series [m KNa, n $K(NH_4)$] $C_4H_4O_6.4H_2O$ and [m $(NH_4)Na$, n $(NH_4)K$] $C_4H_4O_6.4H_2O$. All these crystals are orthohombic and iosmorphous, but when freshly prepared they show crossed dispersion characteristic of monoclinic crystals (borax type). On standing, the crystals show a slow change in the size of the optic axial angles and in the position of the optic axial planes for different colours; and finally, after a lapse of some time, they settle down with all the optic axial planes lying in the plane (100) or (010) or in both, giving in the latter case crossed axial-plane dispersion of the orthorhombic (brookite) type. This change is hastened by rise in temperature and retarded by pressure. Sections from the outer and inner portions of the crystals showed a difference, evidently due to the time taken for growth; but in the final state they are identical, suggesting that the crystals are homogeneous. Other isomorphous series of mixed crystals containing only two of the three bases, namely, [m Na_2, n $Na(NH_4)$], [m $(NH_4)_2$, n $(NH_4)Na$], [m Na_2, n NaK], and [m K_2, n KNa], showed, in the range of the visible spectrum, the optic axial planes all in one plane, but with wide differences in optic axial angle.

On the South African Meteorites, Vaalbult, Witklip, and Queen's Mercy. By Dr. G. T. Prior.

The Vaalbult meteoric iron is a very deeply and broadly pitted mass weighing about 26 lbs., which was found on a farm in the Prieska Division, Cape Province. It is a coarse octahedrite having a percentage of nickel of about 7. The Witklip meteoric stone fell on May 26, 1918, at about 9.40 a.m., after appearance of a luminous meteor and loud explosions, on the farm Witklip in the Carolina District, Transvaal. Fragments weighing together only about 22 grams appear to have been preserved. It is a grey chondrite closely resembling the Cronstad meteoric stone. Of the Queen's Mercy meteorite, a large stone, a foot and a half long, fell on April 30, 1925, at Queens Mercy, about 20 miles from Matatiele, and was broken into small pieces by the natives. A second complete smaller stone, weighing about 950 grams, which fell about 15 miles from Matatiele, was obtained from Chief Jeremiah Moshesh, and is now in the Natal Museum at Pietermaritzberg. It is a veined grey bronzite-chondrite containing about 15½ per cent. of nickel-iron, in which the ratio of iron to nickel is about 10½, and about 5½ per cent. troilite, and having a ratio of magnesia to ferrous oxide in the pyroxene of about 5.

NOTICES OF BOOKS.

Photochemical Reactions in Liquids and Gases. General Discussion held by the Faraday Society. Pp. 236. Price 15s. 6d.

The Faraday Society still continue to hold "General Discussions" extending over two or three days, upon subjects of importance in physical chemistry. The volume just issued contains the papers (and discussions thereon), read at a meeting at Oxford last October, when many distinguished British and continental authorities participated.

Prof. Allmand, in his introductory address on *Einstein's Law of Photochemical Equivalence*, dealt with the work of Einstein and Warburg, and gave a summary of the experimental work. Among those who contributed papers are the following: Prof. Weigert and Dr. Lotte Brodmann; Prof. Winther; Prof. Berthelot; Prof. Lasareff; Prof. Stern; Prof. Plotnokow; Prof. Rice; Prof. Ornstein; and Dr. Roy.

The introductory address to the second part on The Mechanism of Photochemical Reactions was given by Prof. Bodenstein. Prof. Franck; Dr. Chapman; Prof. Berthoud; Prof. Taylor; Prof. Noyes; Dr. Norrish; and others contributed to this section. Prof. Rideal gave a summary of the present position in photochemistry.

Japanese Atomic Weight Table of the Elements.

(附 錄)

原 子 量 表

大正十五年 (1926)

Ag	銀	107.88	Mn	マンガン	54.93
Al	アルミニウム	26.97	Mo	モリブデン	96.0
Ar	アルゴン	39.88	N	窒素	14.008
As	砒素	74.96	Na	ナトリウム	23.00
Au	金	197.2	Nb	ニオビウム	93.5
B	硼素	10.82	Nd	ネオヂム	144.3
Ba	バリウム	137.4	Ne	ネオン	20.2
Be	ベリリウム	9.02	Ni	ニッケル	58.68
Bi	蒼鉛	209.0	**O**	**酸素**	**16.000**
Br	臭素	79.92	Os	オスミウム	190.9
C	炭素	12.00	P	燐	31.04
Ca	カルシウム	40.07	Pb	鉛	207.2
Cd	カドミウム	112.4	Pd	パラヂウム	106.7
Ce	セリウム	140.2	Pr	プラセオヂム	140.9
Cl	鹽素	35.46	Pt	白金	195.2
Co	コバルト	58.97	Ra	ラヂウム	226.0
Cp	カシオペイウム	175.0	Rb	ルビヂウム	85.5
Cr	クロム	52.01	Rh	ロヂウム	102.9
Cs	セシウム	132.8	Ru	ルテニウム	101.7
Cu	銅	63.57	S	硫黄	32.07
Dy	ヂスプロシウム	162.5	Sb	アンチモン	121.8
Em	エマナチオン	222	Sc	スカンヂウム	45.10
Er	エルビウム	167.7	Se	セレン	79.2
Eu	ユーロピウム	152.0	Si	珪素	28.06
F	弗素	19.00	Sm	サマリウム	150.4
Fe	鐵	55.84	Sn	錫	118.7
Ga	ガリウム	69.72	Sr	ストロンチウム	87.6
Gd	ガドリニウム	157.3	Ta	タンタル	181.5
Ge	ゲルマニウム	72.60	Tb	テルビウム	159.2
H	水素	1.008	Te	テルル	127.5
He	ヘリウム	4.00	Th	トリウム	232.1
Hf	ハフニウム	178.6	Ti	チタン	48.1
Hg	水銀	200.6	Tl	タリウム	204.4
Ho	ホルミウム	163.5	Tu	ツリウム	169.4
In	インヂウム	114.8	U	ウラン	238.2
Ir	イリヂウム	193.1	V	ヴアナヂウム	51.0
J	沃素	126.92	W	ヲルフラム	184.0
K	カリウム	39.10	X	キセノン	130.2
Kr	クリプトン	82.9	Y	イトリウム	89.0
La	ランタン	138.9	Yb	イテルビウム	173.5
Li	リチウム	6.94	Zn	亞鉛	65.37
Mg	マグネシウム	24.32	Zr	ジルコニウム	91.2

工業化學雜誌第二十九編第三冊（第三百三十七號、大正十五年三月五日發行）附錄

In recent years the International Committee of Atomic Weights has not pubshed an Annual Table embodying the latest corrections and determinations. The apanese Society of Chemical Industry has recently published the above Table for 926, and we reproduce it as a matter of general interest to our readers.

THE COST OF OIL FIRING.

An Interesting Example From Chili.

By A Well-Known Engineer.

In these days of almost continual coal crisis, many steam users have turned their thoughts to oil firing, and in the chemical industries generally much furnace work can, of course, be carried out very easily and efficiently by oil. The subject is, however, a complicated one, but the essential facts are obviously that oil is far too expensive per unit of heat utilised in the furnace to hope to compete with coal. The whole matter is one of simple calculation, with, say, oil at 18,000 B.Th.U. per lb., and 75 per cent. efficiency in a cylindrical steam boiler as against coal at 11,500 B.Th.U., and 65 per cent., taking approximately average conditions, and very roughly oil will about double the fuel bill under normal conditions in Great Britain. The advantages of coal in this connection, in other countries besides Great Britain, are well illustrated in a recent publication issued by the Department of Overseas Trade (London) entitled "Report on Industrial and Economic Situation in Chile." In this it is pointed out that steamship owners in the latter country are becoming much more keenly interested in improved methods of coal burning because of the continued increase in the cost of oil. The report states that in February, 1923, a coasting steamer that had been burning oil fuel under the boilers since 1913 was equipped with special furnaces "supplied by a London firm to burn Chilean coal screenings." The results proved so satisfactory compared with oil fuel and the ordinary run of mine coal, that three other vessels, also running on the South American coast trade, have been or are being similarly equipped.

The above statement in the report refers to the "Turbine" forced draught steam jet furnace, which has proved to be quite capable of burning the local Chilean friable coal, high in sulphur content, and a number of other ships will be fitted in addition to those mentioned. In the Department of Overseas Trade Report it is also pointed out that in the nitrate fields of Chile several boiler plants have gone back to coal because of the high price of oil, and it may be added that one of these, at Antofagasta, is fitted with "Turbine" furnaces. Incidentally, also, Chili is determined to produce her own liquid fuel by low temperature carbonisation and has recently opened an extensive Government Research Institution at Valpairiso.

There is no question that the practice of burning oil under steam boilers is unscientific in principle and that all liquid fuel should be utilised in the internal combustion engine, while, incidentally, it is doubtful whether in most cases oil for steam generation under marine conditions is such a commercially sound proposition as it is made out to be, even bearing in mind the extra cargo capacity and easy bunkering. But for land practice in most countries, coal is undoubtedly the better commercial proposition under average conditions of operation, while a still further saving can be obtained by adopting more scientific methods both as regards improving the thermal efficiency and utilising any cheaper solid fuels that may be available. Thus the average steam boiler plant only operates at about 60 per cent., as it well-known, but 70 per cent. can be obtained without difficulty.

ROYAL SOCIETY OF ARTS.

The one hundred and seventy-second annual general meeting for the purpose of receiving the Report of the Council, and the Treasurers' statement of receipts and payments during the past year, and also for the election of officers and new fellows, was held in accordance with the by-laws on Wednesday, June 30th, at 4 p.m., at the rooms John Street, Adelphi, London, Sir Thomas H. Holland, K.C.I.S., K.C.I.E., D.Sc., F.R.S., Chairman of the Council, in the chair.

The Secretary read the notice convening the meeting, and the minutes of the last annual general meeting, held on June 24th, 1925.

The Chairman reviewed the year's work and delivered an address on "The Organisation of Scientific Research throughout the Empire."

Officers for the Year.

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*Nominated by H.R.H. the President.

STANDARD TURPENTINE, WHITE SPIRIT AND LINSEED OIL.

The British Engineering Standards Association has recently issued British Standard Specification 243-1926 white spirit, Type 1, for paints; No. 244-1926 turpentine, Type 1, for paints; and No. 245-1926 raw linseed oil for paints. They contain clauses regulating the composition, together with standard reception tests, for the purchase of white spirit, turpentine and raw linseed oil for paints and appendices, giving methods of carrying out the tests. These specifications have been prepared at the request of the paint manufacturers by committee representative of both the buying and manufacturing interests, and, as in the cas of all British standard specifications, they will be reviewed as experience of their working or progress in the industry renders it necessary, and revised issues will be published from time to time. Among other specifications in hand which will be published as completed are the following: Painting Materials: Boiled linseed oil, zinc oxide, zinc oxide oil paste, barytes, asbestone, red oxides of iron, lead chrome and Prussian blues. Ready-mixed Linseed Oil Paints: White lead, tinted white lead, zinc oxide, tinted zinc oxide, black, green and red oxide of iron. Oil Varnishes: Interior, exterior, rubbing and extra hard drying.

ASSOCIATION OF LIBRARIES.

The Association of Special Libraries and Information Bureaux has just issued the *Report* (price 5s.), of the second Conference held at Oxford last year. The object of the Association is to facilitate the coordination and systematic use of sources of information in science, industry and public affairs, *i.e.*, to examine, foster, and coordinate the activities of special libraries, information bureaux, and similar services; to act as a clearing house for these services; to develop the usefulness and efficiency of special libraries and information bureaux under whatever titles they may function; and generally to promote, whether by conferences, meetings or other means, the wider dissemination and the systematic use of published information.

The Association aims at assisting members who desire information of any kind to get into touch with the appropriate library or other body specialising on the subject; it will not itself attempt to build up any centralised organisation to provide the detailed information direct.

It is the endeavour of the Association to establish the principle of free interchange of non-confidential information.

Many distinguished librarians and educationalists participated in the discussions. Among the subjects considered, mention may be made of the following which are of special interest to scientific readers:—Technical translations, Classification and Cataloguing, Filing, Abstracting, and Patents.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

16,021.—Bury, E.—Treating zinc waste. June 25th.

15,951.—Castner-Kellner Alkali Co., Ltd. —Process of manufacturing ammonium chloride. June 25th.

16,064.—Koehler, W. — Forming metal compounds involving phosphorus. June 25th.

15,936.—Suida, H.—Preparation of concentrated acetic acid. June 24th.

Specification Published.

232,264.—Pereira, H.—Process for manufacturing perylene quinones.

253,291.—Pease, E. L.—Manufacture of fertilisers.

243,667.—Le Bris, G.—Process for obtaining electrolytic deposits of chromium.

253,623.—Harold, C. H. H.—Preparation of sterilising agents, germicides, and the like.

231,853.—Petersen, H.—Process of obtaining sulphuric acid.

232,581.—Austral Pigments, Ltd.—Manufacture of ferric oxide.

235,159.—Udylite Process Co. — Electroplating with cadmium.

244,747.—Soc. of Chemical Industry in Basle.—Manufacture of derivatives of pyridine-3-carboxylic acid.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

WESTCOM.

470,027.—Chemical substances used in manufactures and anti-corrosives. —The Western Commercial Co., Ltd., 248, West George Street, Glasgow, C.2. June 30th.

BOVIDERA.

459,209.—Chemical substances used for veterinary and sanitary purposes, and insecticides.—Lauritz Christian Borup, Boldhusgade 4, Copenhagen, Denmark. June 30th.

THORACIDE.

466,019.—Fungicides for horticultural purposes for spraying, painting or washing trees.—J. H. Dennis and Co., Ltd., 21 to 23a, British Columbia House, 3, Regent Street, London, S.W.1. June 30th.

BONILAX.

468,335.—Chemical substances prepared for use in medicine and pharmacy. —Taylors' Drug Co., Ltd., 347 to 359, Burley Hill, Leeds, Yorkshire.

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THE HYDROLYSIS OF POTASSIUM CUPROCYANIDE BY SULPHURIC ACID.

By Alexander Steven Corbet and Rowland Marcus Woodman.

Few recent workers have examined the action of sulphuric acid on cuprous salts, but see Pickering (*J. C. S.*, 1878, XXXIII., 112), Guntz and Bassett (*Bull. Soc. Chim.*, 1906 [3], XXXV., 204), and Ehrenfeld (*Zeit. anorg. Chem.*, 1908, LX., 208), in this connection. The present paper deals with the hydrolysis of potassium cuprocyanide ,$KCu(CN)_2$, by sulphuric acid of varying concentrations.

It is well known that addition of cold, dilute sulphuric acid to potassium cuprocyanide results in a quantitative precipitation of cuprous cyanide.

On distillation of mixtures of the cuprocyanide and sulphuric acid, three more or less definite stages were observed, hydrocyanic acid, carbon monoxide and sulphur dioxide being liberated in the order named. With dilute acid partial solution of the precipitated cuprous cyanide occurred in the initial stages and a small amount of a reddish-brown substance was deposited before a greenish-blue solution was finally obtained. With acid of greater initial concentration a bronze colouration during distillation was followed by a brownish-black deposit. A green solution without intermediate colour changes resulted when the initial concentration of the acid exceeded 60 per cent.

In no case was the theoretical yield of hydrocyanic acid obtained. When the initial concentration of the acid was below 40 per cent., an approximately constant yield of 55 per cent. of the hydrocyanic acid possible was obtained. Increasing initial concentration of the acid yielded progressively smaller amounts of the gas, the yield with concentrated acids being negligible. During distillation the acid concentration continuously increased until finally, in every case, the hydrolysis was completed by practically pure sulphuric acid.

The gradual replacement of hydrocyanic acid by its product of hydrolysis, carbon monoxide, with increase in acid concentration, was normal. The formation of red or bronze and then black precipitates and the evolution of sulphur dioxide were in agreement with the known action of sulphuric acid on cuprous oxide to give copper and copper sulphate and the subsequent reduction of sulphuric acid by metallic copper.

Experimental.

The potassium cuprocyanide was prepared and its purity determined as previously (*J. C. S.*, 1924, CXXV., 1670).

About 0.2 gramme of the salt was weighed into a distilling flask, and excess of sulphuric acid of definite concentration added by means of an attached dropping funnel. The mixture was brought to the boil and the aqueous distillate absorbed in dilute potassium hydroxide. On completion of hydrolysis, the distillate was titrated against 0.1 normal silver nitrate solution.

The results obtained are given in the table. When molecules of hydrocyanic acid are plotted against initial concentration of sulphuric acid, the resulting graph resembles that expressing the hydrolysis of potassium cobalticyanide under similar conditions (*J. C. S.*, 1924, CXXV., 2362).

Table.

Molecules of Hydrocyanic Acid Obtained by Hydrolysis of 2 Molecules of $KCu(CN)_2$.

a = initial concentration of sulphuric %.

a	8.07	19.80	42.08	47.69	53.11	60.00	68.50	82.44
Mols. HCN ...	2.20	2.31	2.12	1.83	1.05	0.55	0.08	0.00

School of Agriculture,
University of Cambridge.

RING CHAIN TAUTOMERISM. PART III. THE EFFECT OF THE METHYL ETHYL GROUPING AND THE GEM DIPROPYL GROUPING ON THE TETRAHEDRAL ANGLE.

By R. F. Hunter, M.Sc., A.R.C.S., D.I.C.

In Part I of this series of articles it will be recalled (*The Chemical News*, 1924, CXXIX, 283), that the experiments of Deshapande and Thorpe (*J. C. S.*, 1922, CXXI., 1430) on $\beta\beta$ diethylglutaric acid were discussed and it was shown that in accordance with the general hypothesis regarding the influence of groups on the depression of the tetrahedral angle, the effect produced by the gem diethyl grouping lies between the effects caused by the gem dimethyl grouping and the cyclohexane ring complex. It will be recalled (*ibid.*), that attention was also directed to the very marked differences in chemical behaviour which accompany comparatively small alterations in the tetrahedral angle, and particularly as regards the stability of the open chain or ring system which is the outcome of the change. Whereas the keto acid is stable in the gem dimethyl series ,it is the cyclohexane spirocyclopropane hydroxy acid which is stable in the six membered ring series, and so much was this the case, that it was not found possible to prepare the ring hydroxy acid in the gem dimethyl series nor the open chain keto acid in the cyclohexane series in spite of the fact that the starting point was in each case the dibromo ester or the corresponding lactone. These results were brought into line, however, by the discovery of Deshapande and Thorpe (*loc. cit.*) that in the gem diethyl series there exists tautomerism between the diethyl hydroxy ring compound and the diethyl keto compound, the two forms being mutually interconvertible in strong potash solution.

There are, however, other points of difference which reveal themselves in the three series. For instance, when the hydrolysis of a dibromo ester of the type of (I) is carried out with ethyl alcoholic potash the products in the cases of the diethyl and cyclohexane series are the same as with aqueous alkali, whereas in the gem dimethyl series, the sole product is an ethoxy derivative of the type of (II). This remarkable action was considered by Perkin and Thorpe in their earlier work (*J. C. S.*, 1901, LXXIX, 729) to be due to the addition of alcohol to the unsaturated compound. It is evident that this fundamental

$$\begin{matrix} CH_3 \\ C_2H_5 \end{matrix} > C < \begin{matrix} CHBrCO_2Et \\ CHBrCO_2Et \end{matrix}$$

(I)

$$\begin{matrix} CH_3 \\ C_2H_5 \end{matrix} > C < \begin{matrix} C(OEt).COOH \\ | \\ CHCOOH \end{matrix}$$

(II)

difference between the dimethyl and diethyl series must rest on the small difference of angle in the two series and in order to study the effect produced by diminishing this difference, a series of comparative experiments were carried out by Singh and Thorpe (*J. C. S.*, 1923, CXXIII., 113) in the methyl ethyl series.

$\beta\beta$ Methylethylglutaric acid was prepared from the methyl ethyl ketone by Guareschi's method (*The Chemical News*, 1924, CXXIX., 66). The anhydride of the acid dibrominates normally to give the dibromo ester (I) which loses ethyl bromide when distilled and passes into the gromo lactonic ester. The dibromo acid was isolated in cis and trans forms, both of which gave the same hydroxy lactonic acid in the gem diethyl series (*loc. cit.*) this is unaltered by strong aqueous alkali and there is thus no tautomerism between the hydroxylactone hydroxyacid and the keto acid as there appears to exist in Balbiano's acid (*The Chemical News*, 1924, CXXIX, 283). Indeed the recurrence of such tautomerism is not to be expected. When the dibromo ester (I) is hydrolysed by ethyl alcoholic potash, it behaves like the corresponding compound in the gem diethyl series and is converted into the ethoxy ring acid (II). The stability of this compound was found by Singh and Thorpe to be remarkable because it was unaltered by strong aqueous alkali even on prolonged boiling and was unaffected by concentrated hydrochloric acid.

The ethoxy acid (II) was partly converted into the ring acid with strong hydrochloric acid and gave the correct "ethoxy value" with the Zeisel method. It was, however with the corresponding methoxy compound namely 1-methoxy 3-methyl 3-ethylcyclopropane 1 : 2 dicarboxylic acid that Singh and Thorpe were able to carry out their experiments and co-ordinate the

behaviour of these apparently abnormal substances with the general hypothesis. The methoxy compound to which we have made reference was isolated in well defined cis and trans modifications, the trans form being converted iuto the cis via the anhydride of the latter. Both isomerides passed on treatment with hydrochloric acid into α keto $\beta\beta$ methylethylglutaric acid that is the keto acid in the methylethyl series which was characterised by the formation of a quinoxaline with orthophenylenediamine and its conversion into the anhydride of methylethylsuccinic acid on distillation.

This, of course, reveals the mechanism of the change, for the action of hydriodic acid is not a reducing one, but merely one whereby the OMe group in the 1 methoxy 3 methyl 3 ethyl cyclopropane 1 : 2 dicarboxylic acid is converted into an OH group in the usual manner, the hydroxy acid that is 1 hydroxy 3 methyl 3 ethyl 1 : 2 dicarboxylic acid is unstable and passes into the open chain α keto $\beta\beta$ methylethylglutaric acid which is stable to 64 per cent. potash. These experiments of Singh and Thorpe clearly afford confirmation of the contention that the alteration of the tetrahedral angle which causes the keto acid and the hydroxy ring acid to be tautomeric in the case of the gem diethyl compound causes also the hydroxy ring to be the only stable form in the cyclohexane series and the keto acid the only stable form in the gem dimethyl series.

At this stage it was clearly necessary to prepare as many $\beta\beta$ dialkylglutaric acids as possible, and compare their behaviour under similar conditions. If the difference in effect between the gem dimethyl and gem diethyl groupings is due to the difference in volume of the two groupings, it would mean that this influence would have to be exerted through the single carbon atom by which, in the case of ethyl, the groups are attached to the β carbon atom, or in other words, we should have to assume that the volume effect of the attached carbon atom is affected by its participation in a chain of carbon atoms of which it is a member. If this assumption were true, it is to be expected that an increase in the length of the chain of which the gem grouping is composed will exert a corresponding influence on the value of the angle formed by the two remaining valencies of the β carbon atom and that this influence could be detected by the stability of the ring structure or open chain compounds derived from the substituted acids in question.

It will be recalled that in the gem diethyl series (*loc .cit.*), that a tautomeric mixture of the open chain keto acid and hydroxy ring acid was obtained containing 62 per cent. of the ring acid and 38 per cent. of the open chain keto acid. Bains and Thorpe (*J. C. S.*, 1923, CXIII., 1206) therefore extended the investigation to the gem dipropyl series, the experiments being carried out with $\beta\beta$ di-n-propyl glutaric acid.

$\beta\beta$ Di-n-proplyglutaric acid was prepared by Kon's modification (*J.C.S.*, 1921, CXIX, 818), of the Guareschi reaction. It was characterised by the formation of the anhydride anilic acid. The acid was converted by the usual methods into ethyl $\alpha\alpha$ dibromo $\beta\beta$ di-n-propyl glutarate which on distillation passed into the bromolactone ester. The dibromo acid and the bromo lactonic ester were also prepared by usual methods. From the dibromo ester a mixture of the keto acid (III) and the hydroxy ring acid (IV) was obtained.

$$\begin{array}{lcll} CH_3CH_2CH_2 & & C(OH)COOH & \rightarrow \\ & >C< & \vert & \\ CH_3CH_2CH_2 & & CHCOOH & \leftarrow \end{array}$$

(IV)

$$\begin{array}{lcl} CH_3CH_2CH_2 & & CO.COOH \\ & >C< & \\ CH_3CH_2CH_2 & & CH_2COOH \end{array}$$

(III)

Determination of the equilbrium mixture between these two substances in 60 per cent. aqueous potash gave 71 to 29 in favour of the hydroxy riug. The ratio is clearly appreciably higher than the 62 to 38 found for the diethyl derivatives (*loc. cit.*). This is, of course, in accordance with the view that the increase in the number of carbon atoms in the chain forming the gem grouping increase the stability of the three membered ring system formed by the other two valencies.

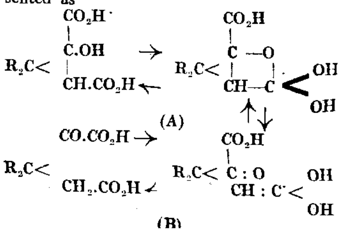
Now the general hypothesis which has been suggested to explain the phenomena discussed in this series of papers (*loc. cit.*) is that the angle between two of the valencies of a carbon atom is altered (a) by the inclusion of the other two valencies in a ring complex, (b) and by the volume of the groups attached to the other two valencies.

It has, however, been suggested that the effect produced in the manner described with regards the effects of the different gem groupings on the tetrahedral angle may not be due as has been suggested to an alteraation in valency direction, but for example

to the induced polarities of the carbon atom forming the gem groupings. In order to meet this criticism Lanfear and Thorpe (*J. C. S.* 1923 CXXIII, 1683) subjected the compounds in which the gem grouping is replaced by a cyclopentane ring to a close experimental study, for it is clear that if the alteration of the tetradedral angle is the determining cause of the observed phenomena with regards this type of tautomerism, the cyclopentane ring whose calculated angle is 109.4° ought to exert an influence similar to the effect of the gem dimethyl grouping, while on the other hand, if polarity were the cause of the observed phenomena, the cyclopentane ring ought to have the same effect as the gem diethyl grouping. The experiments of Lanfear and Thorpe have proved conclusively that the cyclopentane derivatives simulate the gem diethyl derivatives in their reactions and behave *differently from the gem diethyl compounds*, substantiating the hypothesis advanced by Thorpe, Ingold and their collaborators.

The work of Lanfear and Thorpe is particularly interesting for another reason, namely, because the experiments carried out in connection with the cyclopentane derivatives brought to light facts which clearly demonstrate the mechanism of tautomeric change between the keto acid and hydroxyring acids under discussion.

It is somewhat remarkable that the slight variation in the angle should bring about such a great change in chemical properties, particularly when it is recalled that the three membered cyclopropane ring uuder normal conditions is not in reality formed. The experiments of Thorpe and Lanfear, however, have provided a complete explanation of this. It was found by these investigators that ethyl $\alpha\alpha^1$ dibromocyclopentane 1 :21 diacetae on treatment with aqueous potash gives mainly α ketocyclopentane 1 : 1 diacetic acid, but on treatment with methyl alcoholic potash gives a mixture of cyclopentane spiro 1 hydroxycyclopropane 1 : 2 dicarboxylic acid and cyclopentane spiro 1 methoxycyclopropane 1 : 2 dicarboxylic aid. Both cyclopentane spiro 1 hydroxycyclopropane 1 : 2 dicarboxylic acid and ketocyclopentane 1 : diacetic acid are stable towards aqueous potash, but the former is completely converted into the latter by hydrobromic acid and moreover cyclopentane spiro 1 methoxy cyclopropane 1 : 2 dicarboxylic acid yields α ketocyclopentanel 1 : 2 dicarboxylic acid on hydrolysis with hydrobromic acid. At the first it appeared somewhat difficult to reconcile the existence of cyclopentanespiro 1-hydroxycyclopropane 1 : 2 dicarboxylic acid with the general hypothesis and indeed but for the isolation of the methoxy compound and its hydrolysis to α ketocyclopentane 1 : 2 dicarboxylic acid it would have appeared that the cyclopentane derivatives were simulating the diethyl compounds and not the dimethyl compounds, in spite of the fact that the keto acid and the hydroxy ring acid could not be shown to be tautomeric. The problem of bringing these results into line presented many difficulties, until it was discovered that the hydroxy ring acid, unlike any other compound of the type hitherto prepared readily gave an anhydride. It is evidently, therefore, a cis acid with the carboxyl groups on the same side of the plane of the ring whereas all the other hydroxy ring acids previously isolated *in connection with this work were trans* compounds which did not give anhydrides. Aud further, it is evident that only the trans modifications undergo fission, for the fact that cyclopentane spiro 1 hydroxycyclopropane 1 : 2 dicarboxylic acid passes into the keto acid on treatment with hydrobromic acid can readily be explained on the assumption that conversion from the cis to trans form precedes fission. It follows that the two stereoisomeric hydroxy ring acids must behave diffierently the cis being stable and the trans at once undergoing fission to form the open chain keto acid where this form is stable. The only adequate explanation to meet this remarkable fact removes all the difficulty regarding ring formation to which we have made reference, because it is clear that if the trans form is the unstable form, the instability must be due to the interaction between the hydroxyl and the carboxyl group which in this modification are one the same side of the plane of the ring. Consequently, the mechanism of the change has to be represented as



(B)

Tautomerism therefore takes place (in the diethyl and di-n-propyl series) between the two forms A and B (potassium salts) and not directly between the cyclopropane ring and the open chain ketone.

The results of the researches in connection with this work which so far have been discussed are best seen in the form of the table hereunder:—

Grouping	Angle	Keto acid %	Hydroxy ring acid %
2 Hydrogens	115.3	100	0
2 Methyls	109.3	100	0
Cyclopentane	109.4	100	0
Methylethyl	—	100	0
2 Ethyls	—	38	62
2 n-Propyls	—	29	71
Cyclohexane	107.2	0	100

Highbury New Park, N.5.

FLEXIBLE PIPE JOINTS.

A Remarkable Application of Rubber.

By A Well-Known Engineer.

Considerable attention has been drawn of late to the striking properties or rubber as regards resistance to all kinds of deleterious influences especially by the Propaganda Department of the Rubber Growers' Association. From a chemical point of view, it is certainly not easy to quite understand why rubber pavement, for example, has already lasted for over 50 years with little sign of wear and tear, and apparently will go on for another 50, but presumably it is a unique combination of chemical inertness and lack of rigidity so that all mechanical stresses are immediately distributed over a considerable area.

One of the most remarkable applications of rubber, particularly important for the chemical industries, is the "Victaulic" flexible pipe joint. Some of its present uses are water, sea water, sewage, and many other dilute solutions, oil, petrol, benzole, household gas, compressed air and natural gas, as well as many special uses, including hydrochloric acid gas, and, in fact, most liquids and gases other than steam, giving an absolutely tight joint between the wide range of vacuum and 2 tons per square inch.

Also any variety of pipe may be equipped, cast iron, wrought iron, steel and galvanised iron for example, while for the chemical industries Messrs. Doulton and Co., Ltd., supply special earthenware pipes. The essential feature of the design is the use of a heavy ring of high-grade rubber composition, bent over double in section into the form of a flat inverted "U," and contained within an outer metal housing ring. The pipes are made with a slightly raised shoulder or rim at each end, and the encircling metal ring is bolted round in such a manner that the lips of the inner rubber ring press down evenly all round on the rims of the pipe ends, placed loosely together, and the greater the pressure the tighter becomes the joint without interfering with the flexibility. Further, the joint can be made or disconnected in a few minutes by unskilled labour, even in the dark or under water, and as regards the extent of the movement, each separate section or length of pipe can be shifted to an angle of 1° to 5° from the straight in any plane, depending on the diameter. Consequently, in practice a long line of pipe connected in this way is flexible to a very pronounced degree and can be laid, for example, merely on the rough ground without worrying about alignment.

The field of application for such a device is almost endless and it may be stated the invention is a production of Messrs. The Victaulic Co., Ltd., Dean Stanley Street, Westminster, S.W.1 Typical are pipe lines laid for miles in the oil fields for conveying crude oil, natural gas at high pressure, sea water, and fresh water, as well as town water supply and sewage mains. Other important uses are towns' gas, so as to prevent the fracturing characteristic of the ordinary rigid joint, shipbuilding and dock equipment, hydraulic work, and compressed air. The latter is particularly important for collieries in which air for drills, coal-cutters, and other appliances is ideal as regards safety and ventilation, but probably at least 40-50 per cent. of the total output of the compressors is lost, because of leaky rigid pipe joints. Thus the pressure contained in the average pipe line will only hold a few minutes when the valves are closed, and it is not surprising the cost of compressed air is apt to be excessive in comparison with electricity.

With the "Victaulic" joint, however, this loss is almost eliminated altogether, and even for the chemical industries it is a considerable advantage in various ways to have flexible joints for compressed air as well as gas, water, and many solutions. To

return to the subject of the resistance of rubber, the estimates are that in the "Victaulic" joint with completely protected conditions, as described, the life of the ring will last over 100 years, and longer than the pipe itself. For example, Walter Hole, the well-known authority on the conveying of gas, gave in 1924 some most interesting examples of rubber rings in ordinary flanges of buried gas mains, which after 40-50 years were still in excellent condition. Thus in one case, a ring from a gas main in Newcastle after 40 years' use on analysis by the National Physical Laboratory, showed 2.47 per cent. acetone extract; 31.2 per cent. ash; 2.82 per cent. combined sulphur; and 0.56 per cent. free sulphur, while it was in sufficiently good condition for a much longer period, and similar results were given by a ring from a gas main in France after 46 years' service.

HOW CHEMISTRY REPLACES NATURE.

Insulin to be Followed by Other Life-Saving Drugs.

The introduction into medical practice during recent years of the active principle from the pancreas, known as insulin, has rescued from premature death and restored to full and efficient life unnumbered sufferers from diabetes. It is not so generally recognised that insulin is only one, and the latest to come into effective use, of a group of potent principles which the body makes for the control of its vital activities —the so-called hormones. A hormone which came much earlier into practical use in medicine was that of the thyroid gland.

Work on thyroxine, the active principle of the thyroid gland, carried out at University College, London, has by the skill and ingenuity of Dr. C. R.Harington recently yielded the secret of its chemical constitution. The extraordinary potency of thyroxine is comparable with that of insulin. Moreover, Dr. Harington's discovery has greatly cheapened the use of thyroxine so that the expense of employing it in medicine is no bar to its use.

Great interest is being evinced in a discussion which is to take place under the chairmanship of the Rt. Hon. Sir Alfred Mond, a former Minister of Health, at the forthcoming Congress of Chemists in London. Dr. H. H. Dale, who has played a very distinguished part in his contribution to this field of knowledge, will open the discussion, in which biochemists dealing with the scientific aspect of the subject will confer with industrial chemists concerned with the practical side of producing these active drugs on the manufacturing scale.

THE ASSOCIATION OF BRITISH CHEMICAL MANUFACTURERS.

The Tenth Annual General Meeting of the Association of British Chemical Manufacturers was held at the Chemical Society's Rooms, Burlington House, Piccadilly, London ,W., on Thursday, July 8, 1926, for the purpose of receiving and considering the Report and Accounts; the election of Auditors and the transaction of the ordinary business of the Association. D. Milne Watson, Esq., Chairman of the Association, presided.

The General Manager (Mr. W. J. U. Woolcock) having read the notice convening the meeting,

The Chairman said : "Gentlemen, I beg to move 'That the Report of the Council of the Association be and it is hereby adopted.'

In moving this resolution I should like to make a few remarks with regard to the work of the Association during the past year. I have come to the end of my term of office at Chairman of the Association, and my last duty is to present to you the Report of the Council's work during the last year.

My first personal reference is a sad one. I have to refer to the passing of an old friend who was known to us affectionately as Tom Smith. He played a leading part, with others, in the formation of our Association, and was a very useful and congenial colleague on the Council. In business matters he was a doughty opponent with whom to cross swords; as a companion he was a rare friend to have by one's side. The only other personal reference is to our Vice-President, Sir Max Muspratt, whom we very heartily congratulate on his election as President of the Federation of British Industries. Sir Max would, I know, prefer that I should pass lightly over the personal compliment to himself, and I, therefore, stress that aspect of his appointment which does honour to the industry as well as to the man, and we appreciate that honour to the full.

. We ourselves live so closely with the industry that I fear there is a danger of our not recognising how far it has advanced in public opinion during the last few years. We now rank among the first half-dozen of the great industries of this country, and whereas out of every 10,000 occupied persons in 1911 there were 81 engaged in the Chemical industry, in 1921 that number had increased to 115 and is probably considerably higher to-day. Few industries can show such a relative increase as this in so short a time. And I would go further and add that your Association has played a not unworthy part in raising the Industry to the level which it has attained.

The paragraph in the Report which is headed 'Anniversaries' leads me to refer to a gradual development which I have noticed during my term of office. Our Association, which, you will agree, is a purely industrial body, has increasingly associated itself with kindred bodies which are of a more scientific character. Hence we were represented in Paris and in Palermo, and if further evidence of our interest be required, I would remind you that during the past two years the Council has allowed the General Manager to occupy the honourable position of President of the Society of Chemical Industry. By that action we have endeavoured to repay the debt due to that Society which was one of the three Societies instrumental in forming our own Association.

The revival of the British Industries Fair came at a time when we were all rather jaded with Fairs and Exhibitions, but we nevertheless felt it our duty to help the Government, and consequently gave it our support. I probably go as far as most of you in my appreciation of the need of proper publicity and the necessity of showing one's products. I even subscribe to the trite and platitudinous motto which is inscribed on the walls of some of the rooms of the Department of Overseas Trade, 'Goods will not sell themselves.' But indiscriminate advertising of whatever kind, is thoroughly bad, and we are faced with the professional exhibition-promoters who are prepared to run exhibitions of every class of goods under the sun. I think we should exercise our judgment in selecting which exhibitions we patronise and I think we should go into those selected unitedly as an industry, or not at all (hear, hear). Your Council always considers the merits of each exhibition proposed, and I would suggest that members should not commit themselves to participate in any exhibition until the Council has made a recommendation. Taken one by one pressure is brought to bear upon us which is not always of the kind which would succeed if tried on us collectively.

It is inevitable this year that a larger space in our Report should be devoted to the Group concerned with the manufacture of fine chemicals. For one thing these manufacturers have been brought to trial, and have had to give an account of the progress they have made during the past five years. There may be two views whether protection in any form is desirable; there cannot, I think, be any difference of opinion that a careful survey of any industry by an impartial outside body is very stimulating to that industry, and may be very beneficial. Be that as it may, the fine chemical industry has received this stimulation, and it is the business of the 'candid friend' to do his best to see that it is beneficial. The duties have been reimposed for a further ten years by the Finance Bill which is at present before the House of Commons and will, no doubt, become law in the course of the next few weeks. Just as I have suggested that one of the advantages of protection is the necessary investigation of the progress which an industry is making, so I would point to its weakness in that it sometimes tends to make those engaged in a protected industry a trifle lethargic. I confidently expect that this will not be the case in the industry I am reviewing. Members of Group VI. have made great progress which had been handsomely recognised. It is all the more incumbent on them, by continued co-operation, as well as by individual striving, to advance further from the position they have already won.

The paragraph in which the Council records its opinion that progress is being made in the Dyestuffs Industry is noteworthy for its restraint. I doubt whether the Council would have done otherwise even if it had been written after the announcement of the dividend recently declared by the British Dyestuffs Corporation. I think I shall carry Dr. Armstrong with me when I say that a great deal of harm has been done in recent years by viewing the Dyestuffs Industry through magnifying glasses. It suffers, as do all industries, from the necessity of selling its goods as well as making them. It suffers from fierce compe-

by the ordinary method; the amount of solvent required is very small and the losses of solvent reduced to a minimum. The cost of the plant for a given output is much less than that of an ordinary plant, and the amount of refining necessary, when the oil is obtained, is extremely small, so that a greater output is obtained from a given quantity of raw material.

It is interesting to note that in the case of linseed, the oil obtained is free from the characteristic odour of linseed oil, although it possesses its well-known properties.

LEAD-ZINC DISCOVERIES NEAR SUDBURY, CANADA.

The Natural Resources Intelligence Service at Ottawa reports that extensive lead-zinc ore bodies have been indicated by the diamond drilling programme of the Bunker Hill and Sullivan company on the claims near Sudbury being taken under an option from a group with which Jos. Errington is associated. An expenditure of approximately $250,000 has been made within the last ten months and fully 50,000 feet of diamond drilling has been done. The Bunker Hill programme is looked upon as the most interesting new mining operation in the Dominion. The option holders are believed to be almost ready to make an announcement, particularly since all the adjoining ground that was wanted has been secured. The Bunker Hill and Sullivan group is particularly well fitted to bring this mine to the production stage, since it has control of the metallurgical process required for the treatment of the Chelmsford lead-zinc ore.

B.C. PHOSPHATES FOR PRAIRIE SOILS.

British Columbia may soon produce phosphates in large quantities for the enrichment of prairie soils, in the opinion of Hon. William Sloan, Minister of Mines, who announces the discovery of large deposits of the valuable fertilising mineral in the East Kootenal district.

It is stated that the Consolidated Mining and Smelting Company, the largest concern of its kind in Western Canada, will become interested in the deposits. The association of this Company in the project is taken to mean that the deposits will be thoroughly prospected and that if they are proved to be of economic value the capital required will be available to put the industry on its feet.

THE SIR JOHN CASS TECHNICAL INSTITUTE, LONDON, E.C.3.

Appointment of Principal.

The Governors of Sir John Cass's Foundation have appointed Mr. Geo. Patchin, A.R.S.M., as Principal of the Sir John Cass Technical Institute, London, in place of Dr. Charles A. Keane, resigned.

Mr. Patchin was educated at the Royal School of Mines, where he held from 1895 to 1898 a national scholarship, and in 1898 obtained a first place in the first-class in metallurgy in the examination for the Associateship, and the Bessemer medal. In 1898 he was appointed chief assistant in the chemistry department and lecturer in metallurgy at Birkbeck College, subsequently in 1901 becoming head of the department of metallurgy, where he remained until 1912, when he was appointed lecturer in metallurgy at the Sir John Cass Technical Institute. As from 1st July, 1919, he was appointed head of the metallurgy department at the Sir John Cass Technical Institute, which post he has retained until the present time. During the absence of the Principal owing to illness he has been Deputy-Principal and subsequently Acting-Principal of the Institute.

During the forthcoming session, the Institute, which specialises in Physics, Chemistry, Metallurgy, Petroleum Technology, the Fermentation Industries, and Arts and Crafts, will have completed 25 years as a City Polytechnic.

CONGRESS OF CHEMISTS.

In connection with the forthcoming Congress of Chemists to be held in London from the 19th to 24tb uly, an Exhibition has been arranged to take place on the premises of the Institute of Chemistry, 30, Russell Square, of laboratory apparatus and instruments, fine chemicals, reagents, filter papers, scientific books, etc.

Exhibitors.

In the Main Laboratory.

Doulton & Co., Ltd.; The British Drug Houses, Ltd.; Evans, Adlard & Co., Ltd.; Standley Belcher & Mason, Ltd.; The Thermal Syndicate, Ltd.; Townson & Mercer, Ltd.; Harrington Brothers, Ltd.; W. & R. Balston, Ltd.; Baird & Tatlock (London) ,Ltd.; Wood Brothers' Glass Co., Ltd.; The Stream-Line Filter Co., Ltd.; John J. Griffin & Sons, Ltd.; Duroglass, Ltd.; Brown & Son (Alembic Works), Ltd.; W. & J. George, Ltd.; South Metropolitan

Gas Company; S. Bornett & Co., Ltd.; Hopkin & Williams, Ltd.; John Moncrieff, Ltd.; The Worcester Royal Porcelain Co., Ltd.; Boots' Pure Drug Co., Ltd.; A. Gallenkamp & Co., Ltd.; The Scientific Glassblowing Co.; Plowden & Thompson, Ltd.; Ozonair, Ltd.

In the Balance Room.

L. Oertling, Ltd.; H. K. Lewis & Co., Ltd.

In the Rostrum.

H. K. Lewis & Co., Ltd.

In the Council Room.

R. & J. Beck, Ltd.; Adam Hilger, Ltd.; W. Watson & Sons, Ltd.; The Royal Sovereign Pencil Company, Ltd.

British Drug Houses (Graham Street, City Road, London, E.C.1), *Catalogue of Fine Chemicals.*

We have received the handsome catalogue of 104 pp., from the above well-known company. It includes particulars and prices of the various chemicals, including organic and inorganic chemicals, analytical reagents, indicators for determination of hydrogen ion concentration, standard stains, etc. The catalogue is arranged in alphabetical order and so reference to any given commodity, including weight, price, etc., will be found simply and easy .

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

June 24, 1926.

Isotherms of Hydrogen, of Nitrogen, and of Hydrogen-Nitrogen Mixtures at 0° and 20° C. up to a Pressure of 200 Atmospheres. By T. T. H. Verschoyle. Communicated by Dr. F. A. Freeth, F.R.S.

Experimental determination of isotherms of binary mixtures has been limited almost exclusively to mixtures of oxygen and nitrogen. It appears to be tacitly assumed that, for mixtures of the permanent gases, pv-values at normal temperatures are linear fnnctions of composition. This research has been carried out with the object of testing this asumption for hydrogen and nitrogen.

Reliable modern determinations of the isotherms of hydrogen at 0° and 20° C., up to a pressure of 100 atms., are available. For the corresponding isotherms of nitrogen, two conflicting sets of determinations exist, between which a decision is now made. No work on isotherms of hydrogen-nitrogen mixtures has apparently been published.

Isotherms of three mixtures of hydrogen and nitrogen have been measured at 0° and 20° C., and the results prove that the pv-values for the mixtures are far from being linear functions of the composition. Actually, a small admixture of nitrogen with hydrogen has relatively little influence on the pv-values, whereas, a small addition of hydrogen to nitrogen has a comparatively great effect.

The Loss of Energy in Metal Plates of Finite Thickness, due to Eddy Currents Produced by Alternating Magnetic Fields. By E. W. Marchant and J. L. Miller. Communicated by Sir Ernest Rutherford, Pres.R.S.

It has been found that the energy lost due to eddy currents, produced by an alternating magnetic field, due to a flat circular coil, when placed near to metal plates of different thicknesses, reaches a maximum for a certain thickness of plate. With a frequency of 50 cycles the loss is a maximum with copper plates, about 0.4 cm. thick. A similar effect has been observed with zinc plates, though the maximum is not so definite. For some thicknesses of plate, the energy lost with zinc, due to the magnetic field produced by an inductive coil, is greater than that due to copper plates.

The mathematical theory of this phenomenon has been worked out by Prof. Proudman, and it is shown that these results are consistent with theory. The shape of the curve of the magnetic field is assumed to approximate to a Bessel Function of zero order. In an appendix, a new integral is given for determining magnetic fields due to a coil of wire in terms of Bessel Functions, and some curves are included which give the result of computations made with this integral.

The Effect of Occluded Hydrogen on the Tensile Strength of Iron. By L. B. Pfeil. Communicated by Prof. H. C. H. Carpenter, F.R.S.

The paper deals with the results of tensile tests on carbon-free iron carried out during electrolytic pickling, and is divided into three sections : (*a*) tests on iron in the ordinary finely crystalline condition, (*b*) tests on single iron crystals, (*c*) tests on boundary between two large crystals.

Specifications Published.

228,185.—Victor Chemical Works.—Processes for the production of phosphoric acid.

254,050.—Dow Chemical Co.—Manufacture of metal, more especially magnesium, from the corresponding metallic chloride.

235,867.—Elektrizitatswerk Lonza.—Proces for presparing metaldehyde.

254,204.—Chemische Fabrik Gouvan Landshof & Meyer Akt.-Ges.—Process for producing amino-oxy compounds of the aromatic series by electrolysis.

Printed Copies of the full Published Specification may be obtained from the Patent Office, 25 ,Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

Abstract Published.

251,330.—Arsenical insecticides, etc.—Farbenfabriken vorm F. Bayer & Co., Leverkusen, near Cologne, Germany.

Insecticides; fungicides; iron, manganese, zinc, and other arsenites.—Pest-combating agents are prepared by stirring a mixture of arsenious acid, a sulphate of a metal such as iron manganese or zinc, and chalk or its equivalent such as magnesium or barium carbonates ,with a little water, and heating, drying, and powdering the mixture. The quantity of water used is insufficient to dissolve the arsenious acid but this is stated to enter completely into reaction to form the metal arsenite. Other fungicidal or insecticidal ingredients may be added to the powder.

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A COMPACT AND COMPREHENSIVE SERIES OF REACTIONS AND TABLES IN CHEMISTRY.

By ROBERT SAXON, B.Sc., F.C.S.

(*Continued from Page* 36.)

We here give a number of sequences connected with the halogens to demonstrate the advantage of this notation as far as brevity is concerned, and the facts which can be expressed thereby. The student using the notation for himself will not of course write the explanations given here, explanations which of course take up a lot of our space. Consider the following :—

$2Al/3HgCl_2$ - $2AlCl_3/3Hg$, which means
—.—.— —.—.

that aluminium will replace mercury from a solution of mercuric chloride, without the aid of heat, heaving a solution of aluminium chloride and metallic mercury. The dot and dash dine indicates a solute, and we may have expressed such a state by giving the symbol of ionization : meaning that the elements on either side of it are free to take on any new alliances if such becomes possible. Our sequence then would be :—
$2Al/3Hg : 6Cl$ - $2Al : 6Cl/3Hg$, and we should have to understand that $2Al : 6Cl$ means $2AlCl_3$ in solution. The symbol / means "added to" and may at times be replaceable by the symbol :, as in the mixture of two solutes, say, silver nitrate and sodium chloride, thus :— $Ag : NO_3 : Na : Cl$ - $Na : NO_3/AgCl$; where there remains a solute $NaNO_3$ and a precipitate AgCl which of course is not ionized. The AgCl does not carry the cymbol of ionization :, and therefore is recognised as a solid here in a solute. Out notation therefore says that if solutions of silver nitrate and sodium chloride be mixed at the ordinary temperature (the symbol - says such), dissolved sodium nitrate will result along with a precipitate of silver chloride.

We will now introduce an abbreviated means of indicating colour. This may be done by writing the initial and final letters of the colour. Where it is possible that ambiguity might be possible, the colour may be indicated by three letters. Thus the colours of the spectrum would be put as rd, oe, yw, gn, be, io, vt. Even qualifying adjectives may be similarly abbreviated without confusion, as pe be would be pale blue, or rd orange red, oe gn olive green, gn bn green brown, bn bk brown black, yw we yellowish white, by yw brassy yellow or bs yw, gd yw golden yellow, etc. This method will be appreciated from our examples given hereunder.

Instead of the sign of equality used in writing chemical equations we use the symbol - or / placing after the latter the conditions which start or bring about the reaction. Heat is expressed by /t, abstraction of heat or cooling by / - t, warming by /wt, white heat by /it, meaning incandescent heat, red heat by /rt, bright red heat, /brt, the electric furnace heat /et, boiling /bp, melting or fusing /mp, electric spark /st, silent discharge /dt, sunlight /sl, etc. Where we wish to indicate the temperature necessary to bring about a reaction we state the same after the line, thus, /85d, this meaning that at 85 degrees Centigrade the action starts.

A number in front of the line refers to the number of big calories produced by the reaction. If this be nothing and indicated thus, 0/18d, it is the same as saying that at 18 degrees Centigrade no action takes place. Should it be necessary to heat up to 1,000 degrees to start the reaction, and then, say, 150 big cals. are evolved, we state these facts thus :—150/1000d. In short, wherever there is a big number followed by the line /, that number refers to big cals. If heat is absorbed we indicate it as a minus quantity. Thus -120/bp means that 120 big cals. must be supplied to the reaction which will not start below boiling point. If we wish simply to refer to heat either evolved or absorbed without stating the exact amonnt we do so respectively, thus :— n/ - or - n/ -, the reactions here taking place without the application of heat. We can of course make no reference to this thermal part of the equation, as is oftener than not the case. A few examples will illustrate the value of our notation as a space saver.

i $MnO_2/4HCl$ /t $MnCl_2/2Cl/$ $2HOH$, MnO_2 bk, $MnCl_2$ pk

ii $MnO_2/6HCl$ /t $H_2MnCl_6/$ $2HOH$,
H_2MnCl_6 /t $MnCl_2/2HCl/2Cl$

The last refers simply to the decomposition by heat of H_2MnCl_6.

iii $MnO_2/4HCl$ /-t $MnCl_4/2HOH$

iv $3Fe/4HOH$ /bp $Fe_3O_4/4H$

The bp might here mean that the water is boiling, a dotted line under the water will indicate the fact that we are dealing with steam.

v $Mn : Cl_2/Ca : (OH)_2$ - $Mn(OH)_2$ $/Ca : Cl_2$

Means that solutions of manganese chloride and calcium hydroxide mixed at the ordinary temperature of the air give a precipitate of manganese hydroxide and calcium chloride passes into solution. When steam is passed through a mixture of manganese and calcium hydroxides to which air has easy access, $CaMnO_3$ is formed. This may be expressed :—

vi $2Mn(OH)_2/2Ca(OH)_2/xHOH/$ Air /250d $2CaMnO_3/4HOH/$ $xHOH$

without any reference to the state of the reacting substances. The temperature indicates the fact that the water is in the form of steam.

viii $2CaMnO_3/2CaO/2MnCl_2/O$ /t $2CaMn_2O_5/2CaCl_2$

ix $CaMn_2O_5/10H : 10Cl$ /t $CaCl_2/$ $2MnCl_2/5H : 5OH/4Cl$.

Here the 10HCl and the 5HOH are shown ionized. It may be taken for granted that all the other bodies are not dissolved, but solid or gas. In the following only liquids and gases are indicated :—

x $2KMnO_4/16HCl$ /t $2KCl/$
......
$2MnCl_2/8HOH/10Cl$
....

xi $2KMnO_4/12HCl$ /t $2KCl/$
......
$2MnCl_2/6HOH/2Cl_2O/2Cl$
....

xii $2KMnO_4/8HCl$ /t $2KCl/$
......
$2MnCl_2/4HOH/2ClO_2$
....

xiii $7KI/3Cl_2O$ /t $6KCl/KIO_3/6I$
....

xiv $6ClO_2/10KI$ /t $6KCl/4KIO_3/6I$
....

xv $H : ClO_3/5H : 5Cl$ /t $3H :$ $3OH/6Cl$
...

meaning that solutions of chloric and hydrochloric acids are mixed and heated giving liquid water and gaseous chlorine.

xvi $2H : 2ClO_3/2H : 2Cl$ /t $2H :$ $2OH/2ClO_2/2Cl$
...

xvii $H : NO_3/3H : 3Cl$ /t $2H :$ $2OH/NOCl/2Cl$

xviii *$NaNO_3/4H_2 : 4SO_4/3NaCl$* /t $4NaHSO_4/2H : 2OH/NOCl/$
......
$2Cl$
...

It should be understood that NOCl is decomposed by water.

xix $MnO_2/2HNO_3/2HCl$ /t Mn
—.—.—.—.—.—.— —.
$(NO_3)_2/2HOH/2Cl$
—.—.—.—.—.

xx $Mn(NO_3)_2$ /t $MnO_2/2NO_2$
......

xxi $2NO_2/2HOH/Air$ - $4HNO_3$
...... — — ... —.—.

thus blowing air through water along with NO_2 we may recover a solution of nitric acid with which to make further chlorine.

xxii $K_2Cr_2O_7/14HCl$ /t $2KCl/2Cr$ $Cl_3/7HOH/6Cl$

These reactions proceed in the usual reading direction, namely, from left to right. If there were a possibility of the reaction taking place in the opposite direction, that is from right to left, we must express such fact by regarding the line as a circular chain, and supply another link which must be understood to precede the first half of the expression. When barium oxide is heated in air or oxygen, it forms the dioxide which on further heating decomposes to the monoxide. This may be expressed thus :—

BaO/O /t BaO_2 /t

If we wish to state the temperatures at which these reactions take place we can do so thus :—

BuO/O /700d BaO_2 /1000d

In actual practice these temperatures are not necessary, as the oxygen is under pressure, which is relieved for reduction. When steam is passed over heated iron *hydrogen is given off, but hydrogen will* reduce red hot iron oxide, therefore the action is *reversible.* Such can be so expressed :—

3Fe/4HOH /td Fe_3O_4/8H /td

td signifying that the two temperatures are the same.

$MgCl_2$/HOH /t MgO/2HCl / -t is simple meaning that the reaction is *reversible* only when temperature is lowered. The oldest *reversible reaction* is Dr. Priestley's for the preparation of oxygen. Mercury heated becomes red through formation of oxide. If 200 grams of mercury be taken sufficient heat is developed to raise 30 kilograms of water through one degree Centigrade, that is to develop 30 cals. written in our notation 30/. If we further heat the oxide we get back the mercury and at the same time supply 30 cals, or develop - 30 cals. Thus the proposition may be given.

xxiii Hg/O 30/t HgO -30/t

in reality understanding this to take the place of two sequences thus :—

(a) Hg/O 30/t HgO
(b) HgO -30/t Hg/O,

and in xxiii we read the -30/t as being before the first Hg/O. Thus the expression for a *reversible reaction is supposed to be a* circular chain, the last symbol preceding the first. We will continue with a few reversible reactions.

xxiv Ba/O 124/- BaO/O 17/t BaO_2/Air -17/t BaO/O

Here barium burns, producing 124 cals, barium oxide heated gives BaO_2 and 17 cals, and the peroxide must be further heated and supplied with 17 cals to reproduce the oxide.

xxv .Mg/2HOH /bp $Mg(OH)_2$/2H /it

Here we mean to state that at a white heat hydrogen will reduce the hydrate (but not completely). In the ordinary course of events the hydrogen from the first part of *the reaction gets away, and is powerless to* reverse the action, but if not allowed to escape it will certainly reverse it. When such a reaction takes place in a confined space it may be incomplete and reversible. We can express these two facts by brackets and the percentage sign ,thus :—

xxvi ((.Zn/2HOH %bp $Zn(OH)_2$ /2H))

We can state the atmosphere of that confined space between the first pair of brackets, thus :—

xxvii (N(.2Al/3HOH %rt Al_2O_3/ 6H))

xxviii (N(.Mg/HOH %rt MgO/2H))

xxīx (N(.Al/NaOH/HOH %bp $NaAlO_2$/3H))

xxx (HOH(3Fe/4HOH /rt Fe_3O_4/ 8H)HOH)

In the last example, which is that of a reversible reaction, no reversion takes place. The placing of the atmosphere HOH at both ends signifies that this atmosphere constantly passes over the reacting substances, as through a hot tube. As the rt indicates red heat, we need not show that the HOH is steam, and as we may see that *we are dealing with a flowing atmosphere,* we infer that the hydrogen is carried forward away from the possibility of any reversal of the reaction. In such as the following

xxxi 2Cl/HOH /18d HOCl/HCl /30d

which means that at the ordinary temperature, 18 degrees Centigrade, chlorine forms with water hydrochloric and hypochlorous acids, these re-forming chlorine and water at 30 degrees, the reaction is not really reversible. As we alter the conditions we *alter the state of the reacting substances.*

xxxii HOCl /1 HCl/O (light breaks up)

xxxiii $Na.HSO_4$/H.Cl /18d $H_2 : SO_4$/ NaCl /t $Na : HSO_4$/HCl

......

The single dot meaning generally "finely divided," here is used to indicate the ionization of salts in *saturated solution.* Thus

by mixing saturated solutions of acid sodium sulphate and hydrochloric acid we get a precipitate of common salt, and a solution of sulphuric acid. If we heat this *mixture hydrochloric acid gas is given off*, and the sulphate re-formed. The first reaction is due to the fact that there is not sufficient water to dissolve the common salt. The second is brought about by the fact that the heat drives off the gas. If this gas were prevented from getting away the reaction would be incomplete.

When we mix solutions of two salts like common salt and sodium sulphate with water they are *ionized* by solution. We could represent the mixture thus :—

$$Na_2 : SO_4 : 2Na : 2Cl : 2H : 2OH$$

We must write in straight lines, but in reality the ions are mixed, and might be also represented thus :—

$$2H : 2OH : 2Na : 2Cl : Na_2 : SO_4$$

or $$2H : 2OH : Na_2 : SO_4 : 2Na : 2Cl$$

and whatever order we give them the ions are capable of touching aud moving round one another, ready to form fresh alliances other than those which existed before the salts were mixed.

It should be noted that if the sodium takes on the hydroxyl group OH to form an alkali there is free hydrogen from the water ready to form a balancing acid, either sulphuric or hydrochloric. Had there been sufficient water present reaction xxxiii would not have taken place, and the ions would have maintained their aloofness, the sodium leaving the chlorine free.

The maximum ionization with very dilute solution may be shown by double sign, thus : —

$$Na : : HSO_4/H : : Cl/xH : : xOH$$

and there the reaction would end, and not with the precipitation of the sodium chloride. We give a few more reactions connected with the halogens.

xxxiv $K_2Cr_2O_7/14H : 14Cl$ /50d $2Cr Cl_3/2K : 2Cl/7H : 7OH/6Cl$

...

The solids are shown unionized (the dichromate and the chromium chloride), the liquid and solutes ionized (the HCl, KCl and HOH), and chlorine as a gas.

It is possible to express facts in the form of unfinished or unstarted reactions. Thus we may express the fact that sulphuric acid has no action on chromium chloride, even at the boiling point, by giving the number of calories as nil :—

xxxv $CrCl_3/H_2SO_4$ O/bp

xxxvi $CrCl_3/HNO_3$ O/bp

xxxvii $CrCl_3/H$ /t $CrCl_2/HCl$

xxxviii $CrCl_3/3H$ /it 3HCl/Cr

xxxix $NiO/2HCl/2NH_3$ /t $NiCl_2/HOH/2NH_3$

This might have been written thus :—
$(NH_3($ $NiO/2HCl$ /t $NiCl_2/HOH$ $)NH_3$ indicating the fact that the reaction take place in a current of ammonia, but suc would suggest that the ammonia was ther only to prevent the action of the air, where as the ammonia *affects* the *result* as catalyst, and is therefore included on bot sides of the sequence.

xl $NiCl_2/O$ /t NiO/Cl_2

xli $NiO/2HCl/xHOH$ /18d $NiCl_2$ yHOH

xliii $NiCl_2/HOH$ /t $NiO/2HCl$

....

xliv $2NiO/4HOH/2Cl$ - $Ni_2O_3 3HOH/2HCl$

Of course, the hydrochloric acid would b *ionized by the water*, but such fact is no indicated as it does not concern us.

xlv $MgBr_2/2Cl$ - $MgCl_2/2Br$

...... ——

xlvi $MgCl_2/2F$ - $MgF_2/2Cl$

... ...

xlvii $MgBr_2/2F$ - $MgF_2/2Br$

xlviii $MgI_2/2Br$ - $MgBr_2/2I$

xlix $MgI_2/2Cl$ - $MgCl_2/2Cl$

l $MgI_2/2F$ - $MgF_2/2I$

li $LiCl/F$ n/- LiF/Cl

and so on for other metals the negativ radicles replacing one another in the orde F, Cl, Br, I.

lii $2KF/2H_2SO_4/MnO_2$ /t $K_2SO_4/MnSO_4/O/2HF/HOH$

....

liii $2KCl/2H_2SO_4/MnO_2$ /t $K_2SO_4/MnSO_4/2HOH/2Cl$

liv $2KBr/2H_2SO_4/MnO_2$ /t $K_2SO_4/MnSO_4/2HOH/2Br$

——

lv $2KI/2H_2SO_4/MnO_2$ /t $K_2SO_4/MnSO_4/2HOH/2I$

—

lvi $2KF/H_2SO_4$ /rt $K_2SO_4/2HF$

lvii $2KCl/H_2SO_4$ /t $K_2SO_4/2HCl$

lviii $2KBr/2H_2SO_4$ /t $K_2SO_4/2HOH/SO_2/2Br$

lix $2KI/2H_2SO_4$ /t $K_2SO_4/2HOH/SO_2/2I$

lx $2KI/3H_2SO_4$ /t $2KHSO_4/2HOH/SO_2/2I$

lxi $2KI/FeCl_3$ - $2KCl/FeCl_2/2I$

lxii $2KI/4HNO_3$ - $8KNO_3/2HOH/2NO_2/2I$

lxiii $2CuI/3MnO_2$ /t $Mn_3O_4/2CuO/2I$

lxiv $5HIO_3$ /t $3HOHI6I$

lxv $4HI/HIO_3$ /t $3HOH/6I$

lxv $4HI/SO_2$ - $2HOH/S/4I$

lxvi $2HI/H_2SO_4/MnO_2$ - $MnSO_4/2HOH/2I$

lxvii $8HI/H_3SO_4$ /t $4HOH/HSH/8I$

lxviii $2HI/S$ - $HSH/2I$

lxix $10HI/N_2O$ - $2NH_4I/HOH/8I$

lxx KHF_2 /t KF/HF

Hydrogen has a great affinity for fluorine, but

lxxi $Na/3HF$ - $NaHF_2/2H$,

also K. Rb, Cs.

All the mon-metal fluorides are hydrolysed either in the cold or by heating with water. One reason for this is the formation of hydrofluoric acid. Generally a hydrate is formed at the same time

lxxii $PF_3/3HOH$ - $P(OH)_3/3HF$

as also HCl, HBr, and HI

Wherever a fluoride is given in the tables with " hyd " attached there will be formation of HF with water.

lxxiii $C_5H_{10}O_5/xHF$ $xHF5HOH/5C$

lxxiv CaF_2/H_2SO_4 /t $CaSO_4/2HF$, also HCl

lxxv $CaBr_2/H_2SO_4/xHOH$ - $CaSO_4/2HBr/xHOH$, also HI

lxxvi $AgF/2HOH$ n/- $AgF2HOH$

lxxvii $5AgF/6I$ - $IF_5/5AgI$ (Iodine replaces fluorine)

lxxviii $HI/6F$ IF_5/HF

lxxix $2IF_5/5HOH$ n/- $I_2O_5/10HF$

lxxx $2KClO_3/2I$ /t $KIO_3/2Cl$

lxxxii $3KClO_3/2I$ /t $KClO_4/KIO_3/KCl/2O/ICl$

lxxxiii $I_2O_5/10HCl$ /t $5HOH/4Cl/2ICl_3$

lxxxiv ICl/HOH - HCl/HIO

lxxxv $5HIO$ - $2HOH/HIO_3/4I$

lxxxvi $KOCl/ICl$ - $2KCl/KIO_3/2Cl$

lxxxvii $KClO_3/ICl$ - $KIO_3/2Cl$

From these examples it will be apparent that iodine shows more affinity for oxygen than does chlorine ,although there are no oxides of bromine the intermediate element of the group. The iodates including the acid are more stable than the corresponding chlorates.

lxxxviii $3HIO_3$ /180d HI_3O_8/HOH

lxxxix $2HI_3O_8$ /170d $HOH/3I_2O_5$

xc I_2O_5 /320d $2I/5O$

xci KIO_3 /t $Ki/3O$

xcii $KBrO_3$ /t $KBr/3O$

xciii $2KClO_3$ /t $KCl/KClO_4/2O$

xciv $2Cl/HOH$ % $HCl/HOCl$

xcv $2Cl/2KOH$ /-t $KCl/KOCl/HOH$

xcvi $2Br/2KOH$ /-t $KBr/KBrO/HOH$ (both these in the cold)

xcvii $6Cl/6KOH$ /wt $5KCl/KClO_3/3HOH$

xcviii $6Br/6KOH$ /wt $5KBr/KBrO_3/3HOH$

xciv $12Cl/6Ca(OH)_2$ /t $5CaCl_2/Ca(ClO_3)_2$

c $Ca(ClO_3)_2/2KCl$ /-t $CaCl_2/2KClO_3$

The reason for the last reaction will be seen when we compare the solubilities of calcium chloride and potassium chlorate. 100 grams of water dissolve 74 grams of calcium chloride, or 7.2 parts of potassium chloride at 20 degrees centigrade. At Od the respective weights dissovled in 100 ccs

of water are 49.6 and 3.3 grams. Thus it is that as the mixture of calcium chlorate and potassium chloride cools potassium chlorate separates out as crystals. If we represent the mixture ionized at high temperature we see the possibility of the formation of the potassium chlorate as cooling makes its ionization impossible.

Ca : $2SIO_3$: 2K : 2Cl - Ca : 2Cl/$2KClO_3$

ci $Ba(ClO_3)2/H_2SO_4$/xHOH - Ba $SO_4/2HClO_3$/xHOH

cii $KClO_3/H_2SO_4$/HOH /wt (warm) $KHSO_4$/HClO $KHSO_4/HClO_3$

ciii $3HClO_3$ - $HClO_4$/HOH/$2ClO_2$ xxxx

civ $2HClO_4/P_2O_5$ /t $2HPO_3/Cl_2O_7$

cv .HgO/HOH/4Cl - HgCl/2HClO

As there is no heat used it is obvious that the chlorine is in solution.

cvi $Co(OCl)_2/2HNO_3$ - $Co(NO_3)_2$/ 2HClO

cvii (Air($Ca(OCl)_2$/4Cl/2HOH - Ca Cl_2/4HClO)Air)

This reaction takes place in a current of air. Heat would be fatal.

cviii HClO/H_2O_2 - HCl/HOH/2O

cix $Na_2O_2/2ClO_2$ - $2NaClO_2$/2O xxx (Very unstable)

cx $KClO_4/H_2SO_4$ /t $HClO_4$HOH (Strong sulphuric acid, a solution of chloric acid)

cxi 2Br/H_2S - 2HBr/S

cxii 2Br/SO_2/2HOH - 2HBr/H_2SO_4

cxiii $BaBr_2/H_2SO_4$ - $BaSO_4$/2HBr

cxiv 2AgBr/2H /t 2HBr/2Ag

cxv $Fe_3Br_8/4K_2CO_3$ - $Fe_2(CO_3)_3$/ $FeCO_3$/8KBr.

Boil and filter to get rid of first CO_2, and then Fe_2O_3.

cxvi $AgNO_3$/HOH/2Br - AgBr/ HNO_3/HOBr

cxvii HOBr/2Br/$2AgNO_3$/HOH - 2AgBr/$2HNO_3/HBrO_2$ xxx

cxviii 6Br/$5AgBrO_3$/3HOH - 5AgBr/ $6HBrO_3$

cxix KBr/6KOH/6Cl - 6KCl/3HOH /$KBrO_3$

cxx $4KBrO_3/4H_2SO_4$ - $4KHSO_4$/ 4HOH/10O/4Br

The production of iodine should be understood from the following, the proportions of mixed salts being indefinite :—

Sea weed/Na_2CO_3 - M_2CO_3/M_2SO_4/MCl/ MBr/MI /bp M_2CO_3/M_2SO_4/MCl/M : Br/M : I.

The carbonates, sulphates and chlorides are deposited (unionized) but the bromides and iodides (shown ionized) remain in solution.

MBR/MI//H_2SO_4/MnO_2 /t $MnSO_4$/ HOH/Br/I, the I comes first. Such sequences are not quantitative, but merely *give the products without any reference to their proportions.*

Another process :—

Mother liquor/H_2SO_4/HNO_3/petroleum ether - I/p.e. p.e./6I/6NaOH - 5NaI/ $NaIO_3$/3HOH

cxxi NaI/$NaI5O_3$/6HCl - 6NaCl/ 3HOH/6I

Caliche, an impure sodium nitrate, also contains $NaIO_3$

cxxii $2NaIO_3/2NaHSO_3$ - $2Na_2SO_3$/ $2HIO_3$

cxxiii $2HIO_3/5Na_2SO_3$ - $5Na_2SO_4$/ HOH/2I

cxxiv ICl/ICl_3/IBr/IBr_3/ICN/11KI /bp

4KCl/6KBr/KCN/11I. The $NaHSO_4$ is manufactured on the spot, and the impurities are boiled with KI as shown.

cxxv 2KI/2HOH/$TCuSO_4/SO_2$ - $K_2SO_4/2H_2SO_4$/2CuI/little impurity.

The insolubility of the cuprous iodide brings about this reaction as well as the great tendency to form potassium sulphate wherever possible. H_2SO_3 washes the CuI, and boiling with water will remove all impurities. The whole is filtered and the filtrate dried in CO_2. Then

cxxvi CuI /240d Cu/I. Further reactions connected with iodine depend upon its affinity for oxygen.

cxxvii $2I/10HNO_3/HOH$ /t $6HOH/I_2O_5/10NO_2$

cxxviii $2I/10HNO_3$ /t $3HOH/10NO/2HIO_3/$ (Crystals deposited)

cxxix $2HIO_3$ /100d in dry air then /220d HOH/I_2O_5

cxxx (Air(I_2O_5 /250d $2I/5O$)Air)

cxxxi $H_2S/2I$ $2HI/S$ - $H_2S/2I$

cxxxii .$4I/HgO/HOH$ $HgI_2/2HIO$ (finely divided I)

cxxxiii $3HIO$ - $2HI/HIO_3$

cxxxiv $I_2O_5/5CO$ $5CO_2/2I$

Any reducing agent will of course reduce the oxides of iodine.

cxxxv $2I/4HNO_3$ - $HOH/2HOH/3NO/NO_2/I_2O_5$

cxxxvi $2KIO_3$ /t $2KI/6O$ but $5Ba(IO_6)_2/8I/18O$

cxxxvii $2HClO_4/2I/4HOH$ $2H_5IO_6/2Cl$

cxxxviii 2H) 2H : 2OH : H : IO_3 (PbO_2(HIO_4HOH
$HIO_4/3HOH$ $H5IO_6/HOH$

cxxxix KIO_4 300d $KI/4O$ also others, M_5IO_6 more stable

cxl $2H/2F$ 76/xxxx $2HF$

cxli $2H/2Cl$ 44/lxxxx $2HCl$ (light causes explosion)

cxlii $2H/2Br$ 24/- $2HBr$

cxliii $2H/2I$ -12/t $2HI$

In these four the heat of formation is given in big calories. With III heat must be supplied. A few more are given to show how fluorine resembles oxygen, just as other keystone elements like Li, Be, B, C, etc. ,resemble their neighbour at the same height in the periodic table.

cxliv $2H/O$ 69/st HOH

cxlv $Si/4F$ 240/- SiF_4

cxlvi $Si/4Cl$ 122/- $SiCl_4$

cxlvii $Si/4Br$ 71/- $SiBr_4$

cxlviii $Si/4I$ 6.7/t SiI_4

cxlix $Si/2O$ 219/t SiO_2

cl $2Na/2F$ 219/- $2NaF$

cli $2Na/2Cl$ 195/- $2NaCl$

clii $2Na/2Br$ 181/- $2NaBr$

cliii $2Na/2I$ 148/t $2NaI$

cliv $2Na/O$ 101/- Na_2O.

Here sodium shows much more affinity for the halogens than for oxygen.

clv $2Al/6F$ 400/- Al_2F_6

clvi $2Al/6Cl$ 323/- Al_2Cl_6

clvii $2Al/6Br$ 241/- Al_2Br_6

clviii $2Al/6I$ 173/t Al_2I_6

clix $2Al/3O$ 393/t Al_2O_3

The student is recommended to refer to sequence lxxi and explain the same.

THE ASSOCIATION OF BRITISH CHEMICAL MANUFACTURERS.

(Continued from Last Week.)

"With reference to the paragraph headed 'Customs and Excise,' I would only say this: We are continually bringing to the notice of the Board developments in the Industry which are hampered by legislation passed long before any such developments were ever thought possible. We are also hadicapped by restrictions made necessary by the large amount of revenue which is raised by the spirit duties. It is a difficult position for us to attack, but our reception at the Customs House is always very courteous, and in the course of time we shall, no doubt, arrive at a settlement of most of our troubles.

Of legislation this year we have only selected one example—the Rating and Valuation Act, and you will see that the Council is watching the effect of this Act on behalf of the Industry.

The Traffic Committee, as usual, has got through an immense amount of work, and some of the principal items are mentioned in the Report.

I shall say nothing about the Accounts for two very good reasons. One is that I know comparatively little about them, and the second is that the Treasurer always speaks after the adoption of the Report has been seconded, and he knows all about them."

Mr. R. G. Perry formally seconded the resolution.

Mr. C. A. Hill (Honorary Treasurer), having dealt with the Accounts of the Association,

Dr. E. F. Armstrong said: "I think it is desirable that we should say a few words of appreciation of the Report and of your services, together with those of the gentlemen who have supported you. One feels rather in the position of a person who has been invited to a garden party, and received by you on a well-kept lawn in, no doubt, suitable attire. We are expected to walk about and listen to the band, and everything in the garden is beautiful. But as chemists we are people of an enquiring mind and nothing prevents us from wandering around the borders, and we see there are weeds in the garden, some of them, perhaps, wind-borne from other quarters of the world. We know that weeds, if neglected, will grow and even destroy the gravel paths and beautiful lawn. Then, perhaps, as gardeners, we compare our gardens with gardens we have visited in other parts of the world and study whether their method of planting is the same as ours. In our garden we have our beds of geraniums, begonias, possibly dahlias, and so on; but abroad the tendency seems to be to have a great herbaceous border with bushy plants to shelter the more delicate ones from the icy winds, and it seems to me that we have still to learn that lesson in this country. You have, sir, hinted at co-operation, and I am one of those who hold that if we are to have a future for the British Chemical Industry, we must come much closer together than we are, closer together with the word 'British' prominently before us, and not build up sections of the Industry which are strong because they are members of international groups in which, after all, the British voice varies in loudness. From that point of view I do endorse the remark the Chairman has made and I would like to put that forward to-day as the goal for which we must still strive. (Hear, hear.) All of us in this room to-day know that competition has been exceedingly fierce this year. We know that reorganisations abroad indicate that it will become still fiercer in the years to come. I do not think we fear the competition. We have built truly. Our foundations are strong, and even the superstructure is beginning to indicate what the final structure will be like. But we want to design in a new Regent Street building of one type, so that we are proud of the street as a whole. We do not want to have here Gothic, here Italian, and here a skyscraper. It is from that point of view I support the Report and all that you, sir, have said."

The Rt. Hon. J. W. Wilson said that the Annual Meeting was one of those times when Members should be inclined to question, "What are we paying our subscriptions for?" "What have you given us during the last year?" "How much are we better for being Members of this Association of British Chemical Manufacturers?" If they did not put those questions to the Council and enforce them, there was none the less reason why they should not put them to themselves and try and estimate from year to year what progress and what advantage there had been. He did not think it was easy to estimate from one twelve months to another the advantage of an Association such as theirs, but he did feel in the present world tendency, and especially in those countries whose competition we most feel, they were the only representative sign in this country that there is a possibility, in certain contingencies and necessities, of amalgamations and common interests being voiced. They did actually voice their views to Government, but that was only one phase of their existence. They wanted to watch the general interests of their trade and strive to do all they could. He did not anticipate that with their temperament they were likely to see an enormous chemical *Verein* in this country. At the same time that had been brought to a climax in Germany, where the new I.G., with the exception of the iron and steel industry, will be the largest manufacturing combine in Germany and almost in the world. Of course, America would follow suit. At the same time, it was not our way of doing things, and not consistent with our temperament; but we needed to realise that this was an enormous force as long as it was cohesive and would keep together. It was for them, through their Association, in the Council and Annual Meetings, to see that they lent a helping hand to one another in the difficult and complex questions with which they were faced from time to time. Allusion had been made to the coal strike. He was glad they had not had that, but he felt their Association, coupled with the Chemical Employers' Federation, had been a useful link in seeing that the relations between employers and employed were properly conducted in the chemical trade.

Mr. D. Lloyd Howard said he would like to support what had been said by the Chairman and the previous speakers, more especially from the point of view of the Fine Chemical Manufactures. Mr. Wilson said it might be asked what was the use of belonging to the Association of British Chemical Manufacturers? Well, the renewal of the Safeguarding of Industries Act was a matter of enormous importance to the Fine Chemical Industry, and it was a matter which no one firm could possibly tackle. He thought the fact of the existence of the Association of British Chemical Manufacturers had rendered possible an amount of co-operation and of joint work in that and in other matters which was of untold value.

Mr. N. H. Graesser said he felt, having come to the end of another year, they could look back and see the feet of the Chemical Industry more strongly planted than before. With reference to Dr. Armstrong's remarks with regard to more co-operation, it seemed to him that the time factor was important and the task was to employ in the shortest possible time all the knowledge that they had in this country, which was quite a considerable volume if they could only get it working in one direction. He did not know whether there was any possibility of some such thing as a national programme. He always felt they were working very much in the dark until they got something of that kind.

Mr. Bernard Cook paid a compliment to the Council and staff for all the work they had done during the year.

Dr. G. C. Clayton, M.P., said there was distinct interest taken in chemical matters now in the House of Commons and there was also a great deal of interest being taken by the Government in the Department of Scientific and Industrial Research which was following up all the scientific problems and making very great use of the scientific nowledge that we had in this country. It was also keeping in very close touch with the developments on the Continent, and a great deal that was being done for the better use of coal is showing more prospect now of a satisfactory issue. For a long time it looked very hopeless, but latterly the results which had been obtained in the Fuel Department were more hopeful, and he thought that with a little more patience they would get out a method for recovering the valuable products of coal and producing smokeless fuel that is economically possible. Then there was also the further method of producing liquid fuel direct from coal, which was being followed up. The Germans claimed that they had overcome most of the difficulties and he was hopeful that they would not be very far behind—if indeed they were not in the front. They might have seen in the paper that day that there was a Committee in the House considering co-partnership schemes with a view, not to passing any specific legislation, but with a view to advising manufacturers on the possibilities of co-partnership and helping them to make arrangements suitable for their particular industry. He thought that was quite a useful thing to do, to try and get the employees of firms really interested in the success of the undertaking which employs them. Their great difficulty was to persuade the men that they were really vitally interested in the success of the undertaking that gave them employment, and it was in view of that this Committee was going to investigate the different methods of giving the employees of a firm a real interest in the firm which employs them.

The Chairman then put the motion to the vote and declared the Report unanimously adopted.

On the motion of Mr. C. A. Hill, the Auditors, Messrs. Feasey and Co., were appointed for the ensuing year.

The General Manager reported that the following had been elected to the Council—Dr. E. F. Armstrong, Sir John Brunner, Bart., Dr. G. C. Clayton, Mr. W. H. Dawson, Mr. N. N. Holden, Dr. P. C .C. Isherwood, Sir Max Muspratt, Bart., and Mr. R. G. Perry.

Mr. R. G. Perry proposed a vote of thanks to the Chairman, which Mr. C. A. Hill formally seconded, and the proposition was put and carried, amid applause.

The Chairman replied appropriately.

Mr. Dawson proposed a vote of thanks to Mr. Woolcock and the Staff for their services during the past year. This was seconded by Mr. E. V. Evans, supported by Mr. R. G. Perry, and carried, amid applause. Mr. Woolcock returned thanks.

The proceedings then terminated.

General Notes.

BRITISH FOOD MANUFACTURERS' RESEARCH ASSOCIATION.

The Secretary of the Department of Scientific and Industrial Research announces that a licence, under Section 20 of the Companies' (Consolidation) Act, 1908, has been issued by the Board of Trade to the Brtish Food Manufacturers' Research Association which has been approved by the Department as complying with the conditions laid down in the Government Scheme for the encouragement of industrial research.

The Secretary of this Association is Mr. R. M. Leonard, 22, Buckingham Gate, London, S.W.1. The investigations of the Association will be conducted in close co-operation with those of the British Association of Research for the Cocoa, Chocolate, Sugar Confectionery and Jam Trades.

EXPLOSIVES IN MINES.

All blasting explosives permitted to be used generally in fiery or dusty mines belong to the class of detonating explosives, and the ignition of inflammable gases surrounding the borehole depends in a large measure upon the velocity of detonation of the explosive. The study of the velocity of detonation of blasting explosives involves the measurement of exceedingly short intervals of time, a matter of considerable experimental difficulty.

A method has been worked out by which concordant results can be obtained in the measurement of time intervals of the order of one-millionth of a second. The work is described in a paper by E. Jones, entitled, " A Method for the Determination of the Velocity of Detonation over Short Lengths of Explosive " (Safety in Mines Research Board Paper No. 22, H.M. Stationery Office, Adastral House, Kingsway, London, price 9d. net), and form part of the researches that are being carried out by the Explosives in Mines Research Committee.

RESTRICTION ON THE EXPORT OF SCRAP IRON AND STEEL FROM FRANCE.

With reference to the restrictions on the export of scrap iron and steel from France, arrangements have been made with the French Government as regards the distribution among importers in the United Kingdom of the contingent of 30,000 metric tons of scrap metal to be allowed to be exported to this country during the present year.

Under these arrangements, authorisations to participate in this contingent will be issued to British Firms by the Federated Associations of Scrap Iron, Steel, Metals and Machinery Merchants of Great Britain (Weestminster Bank Buildings, 3, York Street, Manchester), and will be approved by the Board of Trade. Applications for such authorisations should be made to the Secretary of the Federation at the address quoted above, and authorisations, which will only be granted to recognised iron and steel merchants or consuming works, will be granted as far as possible in order of application. The material referred to in the application must be part of a contract duly entered into (subject to French export licence), and the authorisation will only be granted on the condition that the material is for exclusive use in Great Britain and not for re-export. It must be understood that any breach of this condition will involve the loss by the firm concerned of their right to participate in the allocation.

Having obtained this authorisation the importer is to send a copy to the French supplier, who will obtain from the competent French authorities the necessary export licence.

Export licences for England will be issued for the present year by the French authorities.

BOARD OF TRADE ANNOUNCEMENT.

Dating of Patents Committee.

A Committee has been appointed by the Board of Trade to consider whether any, and, if so, what change is desirable in the practice of

(a) Dating patents, applied for under Section 91 of the Patents Act, as of the date of application in the foreign State; and

(b) Dating patents granted upon ordinary applications as of the date of application in the United Kingdom.

The main question which the Committee has to examine is whether this practice should be continued or whether patents granted upon applications made under Section 91 should bear some later date, such as the date of application in this

country, or the date of grant of the patent, while still giving the applicant the priority as regards inventorship which must be given to him under international arrangements.

The Committee will be glad to receive suggestions or representations upon the matters covered by their terms of reference. In considering the questions involved, the Committee desires that due regard should be paid to all the interests involved, *i.e.*, the interests of inventors, manufacturers, consumers and the public generally. Communications should be addressed to the Secretary to the Committee, Mr. B. G. Crewe, the Patent Office, 25, Southampton Buildings, London, W.C.2.

BRITISH INDUSTRIES FAIR.

Birmingham "Practically Booked Up" For Next Year.

The chemical industry and the manufacture of druggists' sundries are already both represented at the British Industries Fair next February. The makers of fancy goods head the list with 17 applications; next there come toy manufacturers, and the makers of stationery, leather goods, pottery and chemicals.

In Birmingham, where the hardware and machinery trades will exhibit, the halls occupied last year are practically booked up.

"The Fair promises to be better supported than ever this year," said an official at the Department of Overseas Trade, in an interview. "Many small firms have built up a large business from the opportunities which it has afforded them. I could mention cases, which are almost romantic, of businesses whose foundations have been based on an exhibit at our Fair at a trivial cost.

"This is no exaggeration, because the small manufacturer, who would be content with a stand eight feet square, can obtain all his requirements for a sum of less than £20. Anyone who invests that amount in the Fair will be introduced to the markets of the world by the 36 Commercial Diplomatic Officers attached to our various embassies and legations, 14 Trade Commissioners in the Dominions and Colonies, and 56 Imperial Trade Correspondents, in addition to nearly 400 regular members of the Consular Service, all of whom are working for the success of the Fair.

"In the past the results of that co-operation have been wonderful. For example, one firm which was practically down and out, made last year, thanks to the Fair, £6,000 profit. Another firm which opened in a 'band-box' stand, to-day has 900 feet of the most carefully designed stand in the Fair and sells to Paris bags which are bought there as French and come back to England as such because 'no one in England could make anything so smart or artistic!' Another firm which took £50,000 in orders when the Fair first opened, has an annual turnover to-day of £400,000.

"By the way, February's Fair wil be the thirteenth, and it is going to make thirteen a lucky number!"

THIRTY-SEVEN YEARS TREASURER OF THE ROYAL INSTITUTION.

Presentation to Sir J. Crichton-Browne.

Having resigned the office of treasurer of the Royal Institution, which he had held for 37 years, Sir James Crichton-Browne was presented on July 20 with a memento of his long and valuable services subscribed for by his fellow-members. The gift consisted of a silver-gilt cup of the Empire period.

The Duke of Northumberland, in making the presentation, said a striking testimony to the services which Sir James had rendered was to be found in the fact that when he took office the endowment fund of the institution amounted to £22,734, and now amounted to £122,500. Similarly, the endowment fund of the research laboratory was £62,000 in 1896, and now stood at £88,295. Sir James's work for the institution had been performed in the intervals of a busy life; and in spite of the numerous more or less professional undertakings with which he was concerned he had participated in public life and taken an active interest in many public questions. One motive had actuated Sir James above all things, and that was his love of and zeal for the truth. In their friend they had that rare combination of devotion combined with sound judgment, unfailing tact, and the valuable

quality of inspiring friendship and confidence in all with whom he came in contact. (Cheers.)

Sir James Crichton-Browne, in acknowledging the gift, predicted that the Institution's educational work would continue with increasing success and that it would promote discoveries which would help the industrial prosperity of the country.

Those present included Lady Crichton-Browne, Colonel Harold Crichton-Browne (son), the Dowager Lady Rayleigh, Lady Dewar, Sir Arthur Keith, Sir William Bragg, Sir Robert Robertson, Sir Dyce Duckworth, Sir Ernest Moon, Sir David Ferrier, Sir Alfred Yarrow, Sir Edward Pollock, Mr. Joseph Shaw, K.C., Mr. Robert Mond, Professor H. E. Armstrong, Dr. W. H. Eccles, Mr. C. H. Merz, Mr. H. M. Ross, and Mr. Alfred Carpmael.

THE CHEMICAL PLANT EXHIBITION, 19-24 JULY, 1926.

By John Missenden, B.Sc.

One of the most interesting exhibits at this Exhibition was the Calder-Fox scrubber, a contrivance that is the most extraordinary space and time saver in modern acid manufacture. Dr. Fox explained this invention to me, and, with *models, compared size for size* against the old form of box scrubber. This last always was a nuisance.

With the Calder-Fox—which works best in conjunction with a Kestner fan on the exit side—the actual work of cleaning takes but thirty minutes. All that has to be done is to unbolt a lid, replace the old plates with a spare set, and bolt the lid on again. The actual scrubbing is effected by the particles of acid mist hitting a series of baffles at high speed, condensing, and falling to the floor of the scrubber, whence the condensate is drawn off. The strength of this condensate for sulphuric acid can be as high as 70%, and is purer than the coke-scrubbed variety.

Dr. Fox mentioned that the scrubber can be made to any individual specification, Messrs. Chance and Hut, Ltd., being the manufacturers.

* * *

Some of the devices there were extraordinary, and did full justice to the skill of the various exhibitors. Space will not permit me to mention more than a few quite briefly, although I should like to discuss *each in detail*.

A fertiliser plant was well-worth seeing. Here the offal, bone, and blood *from* slaughter-houses are dried, treated, and ground; the offal becoming cattle food, and the bone and blood becoming artificial manures. The samples that were on show were of a high standard. Industrial Waste Eliminators, Ltd., were the exhibitors.

Non-corrosive metals and other substances were in abundance. Prodonite, Ltd., had a new acid-resisting pitch-concrete composition which could be—and was—worked into all kinds of vessels such as tanks, tubes, and so on. Messrs. T. Firth & Sons, Ltd., also had a non-corrosive metal called "Staybrite," samples of which were put into concentrated acids while I was there, and which were withdrawn untouched. "Ironac" packings and pumps for acids found another interesting stand, as did the well-known and widely used "Vitreosil" (pure fused silica) contrivances.

International Electrolytic Plant Co., Ltd., demonstrated their efficient Knowles hydrogen-oxygen plant, and it was astonishing how they had overcome the familiar difficulties in connection with the commercial hydrolysis. This is an enterprise which laughs at export difficulties to the Continent, where repeat orders are giving them the finest testimonial they could possibly require.

* * *

This is the first exhibition of chemical plant ever held, but it is to be hoped that it will not be the last. A few exhibitions of this kind will be well worth the trouble of organisation, and will clearly demonstrate to the whole world what one-half of it already knows—that British plant and British materials hold the first place with honours.

NOTICES OF BOOKS.

An Introduction to Surface Chemistry. By Dr. E. K. Rideal, with an introduction by Prof. F. G. Donnan, of London. VIII., + 336 pp. Price 18s. net. London: Cambridge University Press, Fetter Lane, E.C.4.

In the course of his excellent preface Prof. Donnan says, "Every student and investigator of surface kolloid phenomena owes Dr. Rideal a warm debt of gratitude for his admirable survey and presentation of a great and rapidly advancing field of physico-chemieal science." This gives in tabloid form a fair estimate of this handsome book. Dr. Rideal brings up to date a careful study of an interesting subject, which has already been treated by some half-a-dozen or more writers. The author has had the advantage of the investigation of these, he has elaborated their investigations, and gives, near the close of his book, facts on colloir chemistry which adds additional importance to the work, which is handsomely produced.

The Use of Sodium Silicate for the Sizing of Paper. By TH. E. BLASWEILER. Translated by L. W. Codd, M.A. (Oxon). Price 10s. 6d. net. London: Constable and Company, Ltd.

This book deals closely with one of the greatest of modern industries — papermaking. If the author has a mission, it is to accentuate the importance of science in connection with the manufacture of paper.

Iron in Antiquity. By J. NEWTON FRIEND, D.Sc., Ph.D., F.I.C. Pp. VI + 222, with sixteen illustrations. London: Charles Griffin & Co., Ltd.

Iron is without question one of the most useful metals to mankind, and hence an authoritative historical work on the subject like that which Dr. Friend has given us is sure to attract, as it deserves, a wide circle of readers. It is a book which can be read with equal interest by an ordinary, as well as a scientific, reader.

Chemical Synonyms and Trade Marks. By WILLIAM GARDINER. London: Lockwood and Sons.

The price is 30s., and the work is cheap at the price. It is a really valuable Dictionary and Commercial Reference book, containing about 20,000 definitions and cross-references. A very useful book in any scientific library.

U.S.A. OFFICIAL PUBLICATIONS.

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New Patents.

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Latest Patent Applications.

17,122.—Brown, R. S.—Utilisation of waste acid liquors. July 8th.

17,162.—Edwards, A. H.—Extraction of copper carbonate. July 8th.

17,169.—Irinyi, A. — Bringing phenolic vapour into reaction with gases. July 8th.

Specifications Published.

254,352.—Waring, H.—Apparatus for the manufacturs of lead oxide.

254,402.—Ehrhardt, E. F., and Hereward, R. M.—Manufacture of naphthylamine sulpho acids.

235,547.—Goldschmidt Akt.-Ges. T.—Process for the production of chlorine compounds of the next higher homologues of ethylene.

254,539.—Bashiloff, I.—Method of separating radium and barium salts.

240,871.—Patart, G.—Synthetic manufacture of liquefied ammonia.

245,421.—Metal Research Corporation.—Reduction of alumina.

Abstract Published.

251,942.—Sulphur; alkaline earth sulphides.—Salzwerk Heilbronn Akt. Ges., Lichtenberger, T., & Flor, K., Heilbronn, Germany. Not yet accepted.

Sulphur is obtained from alkaline earth sulphates by dissolving in molten sodium

chloride or other alkali chloride and adding coke to reduce the sulphates to sulphides. The alkali chloride is then separated from the alkaline earth sulphide by sedimentation and the sulphide is converted, by treatment with vapour or acid, into alkaline earth oxide or alkaline earth salt and hydrogen sulphide, from which sulphur or sulphur compounds can be obtained in known manner.

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The Latest TRADE MARKS

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VAPEX.

468,050.—Chemical substances used for agricultural, horticultural, veterinary and sanitary purposes, but not including medicinal preparations for Birds, Fly Papers, and Fly Catchers, or the like goods.—T. Kerfoot & Co., Ltd., Bardsley Vale Mills, Oldham Road, Bardsley, Lancashire. July 14th.

IPOZO.

470,292.—Chemical substances used for agricultural, horticultural, veterinary and sanitary purposes.—Goodwin-Tidswell, Ltd., Atlas Works, Carnavon Street, Cheetham, Manchester. July 14th.

GLANDEX.

468,563.—Chemical substances prepared for use in medicine and pharmacy.—T. A. Ward & Co., Ltd., 15, Exchange Street, Blackburn, Lancashire. July 14th.

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470,377.—Chemical substances prepared for for use in medicine and pharmacy.—F. T .Metcalfe, trading as Metcalf & Co., Newton Chemical Works, Holland Street, Manchester. July 14th.

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THE CONDITIONS UNDERLYING THE FORMATION OF UNSATURATED AND OF CYCLIC COMPOUNDS FROM HALOGENATED OPEN CHAIN DERIVATIVES IN RELATION TO THE ATOMIC VOLUME TETRAHEDRAL THEORY. PART I. STUDIES IN THE ACTION OF ALKALIS ON α HALOGENATED GLUTARIC ACIDS.

By R. F. HUNTER, M.Sc., Ph.D., D.I.C., A.R.C.S.

In the series of articles, of which this forms the first part, it is proposed to discuss the reason for the failure of the strain theory of A. von Baeyer to account satisfactorily for the relative ease of formation and stability of the different types of carbon ring in view of the recent researches of Prof. C. K. Ingold and his collaborators.

There is an illuminating example of the difficulties experienced in the application of the Baeyer strain theory to the simple homocyclic rings furnished by the experiments of Stohmann and Kleber (*J. pr. Chem.*, 1892 (ii) XLV, 475) on the heats of formation of homocyclic rings. If one plots the thermal numbers to obtain a curve of instability, cyclobutane occupies the crest of the curve, cyclohexane takes the lowest position, while on the grounds of the Baeyer theory, from the angle of strain in the rings, cyclopropane should occupy the crest of the curve and cyclopentane, the lowest point of the curve, and further, while the difference between the thermal figures for cyclohexane and cyclopentane is very trifling, the Baeyer theory would lead one to expect a relatively large difference in stability. (Ingold, *loc. cit.*)

General experience in synthetical organic chemistry confirms the correctness of the thermal measurements rather than the Strain theory, thus it has been repeatedly observed that the methods for the preparation of five, six and even three membered rings fail either completely or partly when applied to the production of four membered cyclobutane rings, and with regards the five and six membered rings, there is on record a wealth of data which indicates that their stability is nearly the same, which although in excellent accordance with thermochemical measurements, is in direct conflict with the theory.

In the face of such difficulties in the examination by means of Baeyer's theory of the simplest types of ring, it is obviously impossible to expect that an indiscriminate application of the theory to more complex cases such as the spiro compounds which have been discussed by the author in this Journal (*Chem. News*, 1924, CXXVIII, 389, 1924, CXXIX, 17, 49), will prove of service in elucidating the molecular condition, and it is therefore necessary to re-examine the question in a more fundamental manner, and this was done by C. K. Ingold in 1921 (*J.C.S.*, 1921, CXIX., 306).

The tetrahedral angle of Baeyer is the angle at the centre of a regular tetrahedral subtended by one of its sides. It is probable however that the tetrahedron representing a carbon atom is approximately regular only when the carbon atom is attached to four atoms of a similar kind, as

to four carbon atoms as in (A). The basic unit for all polymethylene rings is, however, not a quaternary carbon atom, but a secondary carbon atom (B).

```
C       C          H       C
  >C<                >C<
C       C          H       C
   (A)                (B)
```

Now it has been shown by Kopp, Traube and others that the hydrogen atom in organic compounds occupies a smaller volume than the carbon atom, and it is therefore possible that in the methylene group (B) the two carbon atoms attached to the central carbon atom occupy more of the surrounding space than do the two hydrogen atoms. If this is so, the angle between carbon to carbon valencies of a poly methylene chane will not be 109.5° as hitherto supposed but will be some angle greater than this. To each of the four atoms attached to the central carbon atom of the methylene group (B) may be allocated a spherical domain the cubic content of which according to the hypothesis adopted, is proportional to the atomic volume of the element. Apart from this condition, the size assumed for these domains is immaterial and indeed need not even be regarded of necessity as mutually exclusive. If, however, the centres are fixed by supposing the spheres of mutual contact, and are joined to one another and to the centre of an internal sphere having contact with the other four, there is obtained an irregular tetrahedron with two planes of symmetry. If V and v are the atomic columes of carbon and hydrogen respectively, the longest edge of this tetrahedron will be proportional to $v^{\frac{1}{3}}$ and the the angle 2θ subtending it at the internal point will be the required angle between the carbon to carbon valencies. In a similar way the shortest edge will be proportional to $v^{\frac{1}{3}}$ and the subtending angle 2ϕ, the angle between the valencies attaching hydrogen.

It can be shown that under such cirenmstances the angles θ and ϕ are given by the equations.

$$V^{\frac{1}{3}} \sin \phi - v^{\frac{1}{3}} \sin \theta = (V^{\frac{1}{3}} - v^{\frac{1}{3}}) \sin \theta \sin \phi$$

and

$$V^{\frac{1}{3}} \cot \theta + v^{\frac{1}{3}} \cot \phi = \sqrt{2}\ (Vv)^{\frac{1}{6}}$$

of which the solution for θ is

$$\text{Cosec}\ \theta = 1 + v^{\frac{1}{3}},\ \frac{\sqrt{6}(Vv)^{\frac{1}{6}} - (V^{\frac{1}{3}} + v^{\frac{1}{3}})}{2(Vv)^{\frac{1}{6}} - (V^{\frac{1}{3}} - v^{\frac{1}{3}})}$$

Using Traubes values (*Ahrens Vortrage*, 1899, IV., 225) for V and v. we have finally that $2\theta = 115.°$, that is to say that the angle between each pair of carbon to carbon valencies in a polymethylene chain is about 6° greater than hitherto commonly supposed. Accepting the new value it is possible to calculate by how much the terminal carbon atoms of the n-propane chain must approach one another to form the three-membered cyclopropane rings, those of n-butane to form the cyclobutane ring, and so on, the figures so obtained are in excellent agreement with the thermal observations to which we have made reference, that is to say, the angles of the cyclopentane and cyclohexane rings are nearly the same and the cyclobutane ring is less stable than the cyclopropane ring (*J.C.S.* 1921, CXIX., 307), and the figures obtained for the angles of the various homocyclic rings are moreover in excellent accordance with the difficulties experienced in ring losure in synthetical experiments.

The striking effect, of which hitherto no explanation has been suggested, of the gem grouping in promoting ring closure is also readily accounted for. Besides the many examples of the effect of the gem grouping in promoting ring formation in the chemistry of the camphors and bicyclic terpenes, there are many which have been furnished by synthetical experiments, particularly in connection with the preparation of gem dimethylcyclopropane and gem dimethyl cyclopentane compounds. Thus Perkin and Thorpe found that $\alpha\alpha$ dimethylbutane and $\beta\beta$ tricarboxylic acid was smoothly converted into a cyclopentanone derivative by merely boiling its sodium salt with acetic anhydride (*J.C.S.*, 1904 LXXXV., 138), a change which has never been observed to occur with adipic acids containing no gem dialkyl grouping. The effect is also equally apparent in heterocyclic ring formation, thus whilst the α hydroxy and the $\alpha\alpha'$ dihydroxy derivatives of $\beta\beta$ dimethylglutaric acid cannot be obtained in the free state owing to change into lactones, the corresponding hydroxy and dihydroxyglutaric acids can be isolated and are relatively stable substances. In a similar manner, whilst glutaric anhydride is easily decomposed by water, $\beta\beta$ dimethylglutaric anhydride may be boiled for hours without change and $\alpha\beta\beta$ trimethylglutaric anhydride actually crystallises from hot water with water of crystallisation (*J.C.S.*, 1899, LXXV., 65). It may also be noted that the only beta lactones contain the gem dialkyl

grouping (*Berichte*, 1897, XXX., 1955).

These contrasts are clearly explicable by the theory that groups attached to a carbon atom bearing two methyl radicles are in closer proximity than the same or similar groups attached to a carbon atom combined with two hydrogen atoms.

The fact that these effects are not due to the repulsion of electrically similar methyl groups, but are essentially connected with volume relations is proved by the occurrence of cases in which electrically dissimilar groups as methyl and carbethoxyl take the place of the gem diaklyl grouping, as for instance in methyldiacetylsuccinic ester, which, under exceedingly mild conditions is conditions is converted into a five carbon ring ketone, a type of change which cannot be brought about in the case of the unmethylated analogue (*Berichte*, 1914, XLVII., 298). When the components of the gem grouping themselves form part of a ring, a further convergence of the attached groups may take place (*J.C.S.*, 1915, CVII., 1080).

In direct contrast to the effect of the gem grouping in promoting the closure of three, four and five membered carbon rings is that of the semi cyclic double bond. Clearly, according to the hypothesis that the spatial configuration of unstrained molecules is determined by the relative volumes of the component parts, the presence of a potential semi cyclic double bond, whilst hindering the formation of smaller rings, should promote that of seven and eight carbon rings. An instance that this is so is afforded by the cyclic ketones, for although cyclopropane and cyclobutanone cannot be obtained by the Wislicenus method, cycloheptone is produced in fairly good yield.

In view of the large number of facts which are satisfactorily collated by the modified strain theory, it seemed desirable to undertake a series of investigations with the object of justifying the introduction of atomic volumes into this branch of stereochemistry. The prime necessity clearly was to follow some one method of ring formation throughout all the obtainable types of alicyclic ring, starting with the cyclopropane ring, this being the reference case with which the closure of other rings is compared, and further, it was necessary to devise a method of experiment which should be carefully standardised and placed on a quantitative basis. It is clear that a great deal depends on the method of ring formation adopted, it is obviously quite unsatisfactory to employ a method such as that of Dieckmann which fails in its application to the lower rings through the entrance into the reaction of more than one molecule of the open chain substance. Perkin's method although wide in its application, suffers from the disadvantage that the results are affected by the reversible alcoholysis of the sodio esters employed, and it is difficult therefore, to draw conclusions regarding the questions at issue. Further, it is clear that although the reaction chosen for an investigation of the type discussed, must be of a sufficiently enforced character to ensure the production at least to some extent of the more highly strained rings, there should always be possible under the conditions of the experiments some standard reaction with which the ring reaction may compete. The progress of ring formation in competition with the side reaction is, then, a measure of the ease of the production of the ring.

The reaction which appeared best to fulfil these conditions was that by which caronic acid was first prepared (*J.C.S.*, 1899, LXXV., 48), from $\beta\beta$ dimethylglutaric acid, that is by the elimination of hydrogen bromide from the alpha bromo substitution product by means of alkali. The method has also been applied to the preparation of cyclic compounds from other $\beta\beta$ disubstituted glutaric acids (*J.C.S.*, 1915, CVII., 1080, and *J.C.S.*, 1920, CXVII., 591, 1920, CXVII, 1579). In all these cases, the formation of an unsaturated derivative simply by the elimination of hydrogen bromide from the bromo acid is impossible, very little work appears to have been done on the application of the method to the more simply constituted dibasic acids, such as glutaric and adipic acids, the alpha halogen derivatives of which might be expected to yield unsaturated as well as cyclic elimination products.

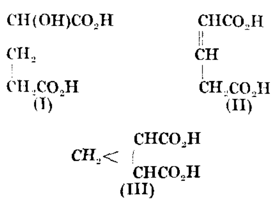
The standard side reaction in all these cases is the replacement of the halogen atom by the hydroxyl group, a reaction which, so far as ascertained by preliminary experiments, takes place with approximately equal ease when the different bromo acids are treated with dilute solutions of alkalis. Under these conditions, the extent to which direct elimination of hydrogen bromide occurs is always slight even if capable of detection. When, however, more concentrated solutions of alkali are used, and particularly where water is replaced by alcohol as solvent, direct elimination is

favoured at the expense of hydroxylation, and may become the main reaction. The elimination may, moreover, proceed in two directions, to give in the one case an unsaturated acid and in the other a cyclic compound. Thus from every monobromo acid *there should arise three products*, for instance, α bromoglutaric acid should give rise to α hydroxyglutaric acid; glutaconic acid and cyclopropanedicarboxylic aid, and in a *similar way* α bromoadipic acid should give rise to α hydroxyadipic acid; Δα dihydromuconic acid and cyclobutanedicarboxylic acid.

It was therefore anticipated that an examination of the proportions in which these various substances were produced from the different bromo acids under standard experimental conditions should yield valuable evidence on the tendency to the formation of the different rings, and on the peculiar *position in the theoretical scheme* occupied by the double bond. The first investigation was carried out by Prof. C. K. Ingold, and dealt with the products derived from halogenated glutaric acids, the α monobromo and αα' dibromo derivatives of which were treated under two standard sets of experimental conditions.

It had already beeu shown hy Perkin and Tattersall (*J.C.S.*, 1905 LXXXVII, 366), that *trans* cyclopropane 1 : 2 dicarboxylic *acid is one of the substances formed when* ethyl α bromoglutarate is treated with concentrated alkali. Crystals of this acid were actually deposited from the syrup obtained by acidifying the product of the reaction.

When ethyl α bromoglutarate is boiled with 2N sodium carbonate, simple hydroxylation occurs almost entirely, α hydroxylglutaric acid (I) or its lactone forming about 95% of the product. Trans cyclopropane 1 : 2 dicarbovylic acid (III) was also obtained in 3% yield, but no trace was found of glutaconic acid (II).



(I) (II) (III)

When 6N methylalcoholic potash is used in the place of the sodium carbonate, the same substances are produced but in different proportions and in company with others. Glutaconic acid was isolated in this case, but only in a small amount. The cis form of cyclopropane 1 : 2 dicarboxylic acid was also obtained, in addition to these a small amount of paraconic acid evidently a product of fission of one or both of the cyclopropanedicarboxylic acids was isolated. The method employed for the separation of these substances which included a fractional distillation, rendered it impossible. to account for all the material, but the products isolated by Ingold were as follows :—

Hydroxyglutaric acid	...	16%
Glutaconic acid ...	...	3%
cis-cyclopropane acid	...	35%
trans cyclopropane acid...		4%
Paraconic acid ...	...	8%
Total isolated	...	66%

The figures indicate in a clear manner the remarkable tendency towards the formation of cyclopropane derivative by the elimination of an alpha hydrogen along with a bromine atom. If in the place of paraconic acid count be taken of the equivalent quantity of cyclopropane dicarboxylic acid from which one must assume it is derived, then at least 47% of the two stereoisomeric forms of the latter acid are produced in the reaction. *In striking contrast to this, the* elimination of the beta hydrogen atom to form glutaconic acid takes place only to the extent of 3%.

It might be added at this point, that the remarkable tendency towards the formation of the cyclopropane ring indicated by these results is strongly brought about by the singular contrast which the investigation of the mono and dibromo adipic acids provides.

Interesting results were obtained on extending the investigation to the αα' dibromo ester. The dibromination of glutaric acid had been investigated by Auwers and Berhandi (*Berichte*, 1891, XXIV, 2230), who isolated a dibromo acid melting at 169° to 170° C. This acid, although the least soluble and most easily isolated, is not the only product of dibromination, but forms about two-thirds of the mixture of two isomeric acids. These two acids melt at 170° and 142°, and are evidently identical *with the* two bromo acids prepared by Thiele (*Annalen*, 1901, CCCXIV., 305), by the oxidation of the cis and trans forms of 1 : 4 dibromo 2 : 3 dihydroxycyclopentane,

Since the cis form yields only the acid of higher melting point, and the trans acid only the lower melting acid, it is clear that the former must be the meso form of dibromoglutaric acid and the latter the racemic compound. A boiling solution of sodium carbonate rapidly converts both these bromo acids into their corresponding dihydroxy compounds, the product actually isolated is not the free dihydroxy acid but its monolacone or a mixture of this with the hydroxy acid, the dihydroxy acid from the meso dibromo acid is stable up to its melting point of 162°, but above this temperatnre eliminates water yielding a monolactonic acid melting at 150°. The dihydroxy acid from the racemic bromo acid, is much less stable, it evolves water vapour at 100° and almost instaneously at 125° changes into a monolactonic acid melting at 168°.

The acid obtained from the meso dibromo acid appears to be identical with that obtained by Kiliani and Matthes (*Berichte*, 1907, XXXX., 1238), by eliminating carbon dioxide from $\alpha\gamma$ dihydroxypropane $\alpha\alpha\gamma$ tricarboxylic acid.

When methyl or ethyl dibromoglutarate is hydrolysed with 2N sodium carbonate, the hydroxylation products constitute more than 90% of the total yield, the remainder consists mainly of a bromo cyclopropanedicarboxylic acid (IV), on prolongued boiling with sodium carbonate a replacement of the bromine atom by the hydroxyl occurs and the cyclopropananoldicarboxylic acid (V) is produced.

$$CH_2<\begin{matrix}CBrCO_2H\\|\\CHCO_2H\end{matrix} \qquad CH_2<\begin{matrix}C(OH)CO_2H\\|\\CHCO_2H\end{matrix}$$

(IV) (V)

The action of sodium carbonate therefore pursues a course analogous to that in the case of the monobromo ester. It was therefore expected that on treating the dibromo ester with methyl alcoholic potash that the formation of hydroxylation products would be reduced to a minimum and a large yield of the hydroxy acid (V) would result. The acid (V) cannot, however be obtained by the action of methyl alcoholic potash because the cyclopropane ring, although no doubt originally formed, is unstable under the conditions of experiment. The material actually isolated consisting of about 10% of hydroxylation products and a mixture of two other acids. The acid present in smaller quantity is methoxycyclopropane 1 : 2 dicarboxylic acid (VI) whilst the main constituent is α ketoglutaric acid (VIII).

$$CH_2<\begin{matrix}C(OMe)CO_2H\\|\\CHCO_2H\end{matrix} \qquad CH_2<\begin{matrix}COCO_2H\\ \\CH_2CO_2H\end{matrix}$$

(VI) (VII)

The main bulk of the ketonic acid is produced by the fission of the cyclopropane ring and not by way of a hydroxyglutaconic acid through tautomeric change, this is proved by the fact that 1 bromocyclopropane 1 : 2 dicarboxylic acid (IV) which is the first product of ring closure when treated with concentrated methyl alcoholic potash yields a mixture of the methoxy acid (VI) and the ketonic acid (VII) in about the same proportion as that when ethyl dibromo glutarate is hydrolysed under similar experimental conditions, the mechanism probably being

$$CH_2<\begin{matrix}CHBrCO_2Et\\ \\CHBrCO_2Et\end{matrix} \rightarrow \qquad CH_2<\begin{matrix}CBrCO_2H\\|\\CHCO_2H\end{matrix} \rightarrow (VI)$$

$$\leftarrow$$

$$CH_2<\begin{matrix}C(OH)CO_2H\\|\\CHCO_2H\end{matrix} \rightarrow \qquad CH_2\begin{matrix}C(OH)_2CO_2H\\ \\CH_2CO_2H\end{matrix} \leftarrow (VII)$$

Ingold's researches on the subject of the halogenated adipic acids will be dealt with in a subsequent article, but it might be said at this point that there is a marked difference between the behaviour of α bromo and α chloro adipic esters and α bromoglutaric ester on treatment with concentrated methyl alcoholic potash, for only a trace of tbe expected cyclobutanedicarboxylic acid is produced in the former.

Highbury New Park, N.5.

British Association for the Advancement of Science.

PRESIDENTIAL ADDRESS BY H.R.H. THE PRINCE OF WALES.

The 1926 Meeting (the 96th year) was opened at Oxford on August 4. H.R.H. The Prince of Wales delivered the Presidential Address. After some preliminary remarks, he said : " The services rendered to mankind by the labours of outsanding figures in Science, such as Faraday, or Kelvin, or Pasteur, or Lister, are matters of too common knowledge to need insisting upon in this place. What is perhaps less generally appreciated is the extent to which, through the efforts of very numerous workers, the results of scientific research have been brought to bear upon many of the most pressing domestic and industrial problems of the day, and the co-operation between the laboratory and the State greatly strengthened of recent years. The *British Association has always supported* such co-operation. One of its principal aims, as stated by its founders and maintained ever since, is ' to obtain more general attention for the objects of Science and the removal of any disadvantages of a public kind which impede its progress.' In an article contributed by Brewster to the *Quarterly Review* in 1830, he asserted frankly that ' the sciences of England ' were ' in a wretched state of depression, and their decline is mainly owing to the ignorance and supineness of the Government,' as well as to various other causes which he detailed. The same theme (if less forcibly stated) recurs in some of the earlier addresses from the chair of the Association : the Prince Consort, for example, as President in 1859, thus indicates his view of the situation at that time—' We may be justified in hoping,' he said, ' that by the gradual diffusion of Science, and its increasing recognition as a principal part of our national education, the public in general, no less than the legislature and the State, will more and more recognise the claims of Science to their attention ; so that it may no longer require the begging-box, but speak to the State, like a favoured child to its parent, sure of his parental solicitude for its welfare ; that the State will recognise in Science one of its elements of strength and prosperity, to foster which the clearest dictates of self-interest demand.'

It may be fairly said that the position foreshadowed in those words is now, in a large measure, attained. The progress towards it was visible, if slow, down to the end of the last century, but the beginning of a new era was then marked by the establishment of the National Physical Laboratory. This was at first set up in Kew Observatory, a building which, as a laboratory for magnetic and meteorological observations, and for the standardising of instruments, owed its maintenance to the British Association for thirty years from 1841, when, as a royal observatory, the Government decided to dismantle it. The building proved incapable of extension to accommodate the whole of the work, and in 1900 Bushy House, Teddington, was placed at the disposal of the laboratory by the Crown. The laboratory, at its inception, was divided into departments dealing with physics, engineering and chemistry, and it possesses also the famous William Froude experimental ship tank. The investigations with which it has been so largely concerned —the testing and standardisation of machines, materials, and scientific instruments, researches into methods of measurements with the utmost accuracy, work on scale-models of ships, and the like—while of the first importance to Government Departments concerned with the applications of science, have also achieved many valuable results for industry in improving standard qualities, in indicating scientific methods applicable throughout a variety of manufactures, and thus in bringing about an improvement in the quality of their output for the benefit of consumers—which is to say, ourselves.

In historical sequence among the events which have strengthened interaction between Science and the State, there follows the establishment of the Development Commission in 1908. Until that date the only agency for agricultural research in Great Britain was the classical experimental station at Rothamsted, a private benefaction; and the expenditure of the State on this prime factor in national economy was trifling. Since 1908 the Rothamsted station has been expanded to cover the

whole field of nutrition and disease in the plant while other institutes have been founded to deal with other aspects of agriculture such as plant breeding, the nutrition and diseases of animals, agricultural machinery and the economics of the industry. Not only are these institutes providing knowledge for our own farmers, but they form the training-ground for agricultural experts required by the Dominions, India, and the Crown Colonies, which need no longer look abroad for their advisers. At the plant-breeding institute at Cambridge, Sir Rowland Biffen has provided several new wheats, of which two are generally grown throughout the country; the extra yield and value of these wheats must already have more than repaid the whole expenditure on agricultural research since the institute was founded. Among other examples of the value of research there may be mentioned the discovery of a variety of potato immune from the ineradicable wart disease, which a few years ago threatened the principal growing districts. The clearing up of the confusion into which commercial stocks of fruit trees had fallen has ensured that growers may plant orchards upon uniform stocks suitable to the soil and climate. And among the most important inquiries are those into the production and cleansing of milk, which have resulted in an entire reform of rationing, increasing the yield of each cow by one to two hundred gallons a year, and in freeing milk from the risk of contamination with disease.

Research into fisheries (which are administratively associated with agriculture), has become a matter of necessity in the light of evidence that even the vast resources of the sea have their limit, and can be injured if they are not exploited with due care and knowledge. Great Britain, acting in co-operation with the other nations who share with us the northern seas, has accomplished much in ascertaining the causes of the fluctuating herring supply, and has contributed notably to the study of the methods by which stocks of plaice can be maintained. Research again is active in finding methods by which we can mitigate one of the consequences of our dense population—the pollution of our rivers and estuaries, and a method has been found whereby great supplies of shell-fish that had been condemned are once more available as food. Some of my hearers will know, too, of the remarkable results obtained from the scientific study of the habits of the salmon. Though fishing has been described as 'a fool at one end of a string and a worm at the other,' the subject is not without its personal interest, I believe, to many learned men.

Reverting to the historical sequence, it is appropriate to recall, with gratitude for its labours, the constitution of the Medical Research Committee in 1913, under the Insurance Act of 1911 : this has since (in 1919) been transferred to a committee of the Privy Council under the name of the Medical Research Council, and its funds are directly voted by Parliament instead of being drawn from the contributions made by or on behalf of insured persons.

Research alone could provide the knowledge on which must be based all wise and effective legislation or administrative action in the interests of the nation's health. Yet until 1913 the State had played at best a subsidiary part in the organisation of such research and the provision of its material support. Under the new conditions the State is actively concerned with the promotion and co-ordination of medical research towards conquest of those infirmities with which ignorance has afflicted humanity. A few only may be mentioned, which have rightly appealed to wide public interest. Insulin, a gift to science and to humanity from young enterprise and enthusiasm in the Dominion of Canada, is not only saving lives that were threatened, and restoring almost to normal health and enjoyment many that were crippled hy weakness and restriction, but, as a tool of investigation, is shaping new knowledge that will influence all our ideas of the functions of the body, in health or disease. The discovery of the vitamins, those still mysterious and minute constituents of a natural diet, has brought understanding of various defects of health and of development, created for us largely by the blindness of civilisation to daugers accompanying its progress, dangers which science can avert. Closely linked with the discovery has been the more recent development of knowledge concerning the need of sunlight for health in man and his fellow animals as in plants. We know now that crippling deformity appears in the growing child unless he receives his proper share of the vitalising rays of the sun, either directly or through the presence in natural foods of vitamins which these

rays have produced. Sunlight, or its artificial equivalents, have some importance already in the treatment of disease; but a realisation of its significance for health has a much greater importance in preventive hygiene. There can surely be no plainer duty, for a State charged with the health of an industrial civilisation, than to promote with all its resources the search for such knowledge as this, as well as to provide for its application when obtained.

Among diseases which painfully affect the popular imagination, cancer has an evil pre-eminence, largely on account of its mysterious, and therefore seemingly inevitable nature. For many years past a volume of investigation, supported by private benefactions and organised charity, has patiently accumulated knowledge of the beginnings of cancer and the conditions of its growth. Now, at length, there are signs of more rapid progress towards a penetration of its secret. Patience and caution are as necessary as ever; a new and exacting technique is still in development; but there is a new spirit of hope and enthusiasm. And it is reassuring to know that in this, as in other directions, the State is giving its direct support to investigation, and co-operating with the foundations due to private generosity.

Looking backward a dozen years or so, one may say that Science was definitely, by that time, a working part of the machinery of the State, though, as we see now, not a part working at full power. The Great War caused a broadening, so to speak, of the scientific horizon for men of science themselves in some measure, but for the layman in a measure far greater. We all were brought to recognise the applications of Science as adding, it may be, in certain respects to the distresses of warfare; but also as immensely alleviating the sufferings caused by it, and as indicating many methods of strengthening the arts of defence—some of which methods are no less valuable in strengthening the arts of peace. The creation of the Government Department of Scientific and Industrial Research was an act which falls, historically, within the period of the war; but as an outstanding incident in the scientific advancement of national affairs, it certainly is not to be regarded as merely a war measure; it was once described as a near relative of 'Dora,' but that was a mistake. Nevertheless, by an odd freak of history, it needed the whole period of a century between one great war-time and the next— between the Napoleonic and World Wars—to mature the conception of a State department of scientific research.

A recent report of the Committee of the Privy Council for Scientific and Industrial Research shows that under the Department there are eleven research boards, some of which direct the work of committees to the number of three dozen in all. These boards co-ordinate and govern researches in chemistry, fabrics, engineering, and physics, radio, building, food-investigation, forest-products, and fuel; and to these are to be added the board of the Geological Survey and the executive committee of the National Physical Laboratory. Under the general supervision of the Advisory Council there are upwards of twenty industrial research associations, formed in alliance with the same number of the principal industries of the country, for the purposes of scientific investigations connected with those industries. No attempt can be made here to review the whole field of work of these various bodies; but a few examples may be chosen for the purpose of pointing out what may be called their homely application. First, then, as to the building of the home. The Building Research Board was created in 1920, and in 1925, at the request of the Ministry of Health, considerably extended its activities. Researches are concerned with the study of materials from the chemical and geological aspects, their strength, weathering, moisture condensation on wall coverings, acoustics, and various other problems.

Next, a further word as to our food supplies. The Food Investigation Board directs committees concerned with meat and fish preservation, fruit and vegetables, oils and fats, and canned goods. There is also a committee for engineering problems associated with the investigations; conditions of storage have been investigated on ships between this country and Australia, and problems of heat-conductivity at the National Physical Laboratory, while chemical substances suitable for refrigerants have been studied at the Engineering School here in Oxford. At Cambridge a low-temperature research station has been established on ground given by the University, and is working in co-operation with the University bio-chemical, botanical, agricultural, and other laboratories. As for the investigations upon fruit and vegetables, the report may again be quoted, for it illustrates in a sentence something approaching the ideal

of scientific co-operation brought to bear upon one particular home necessity, and (what is more), upon a particular and important branch of Imperial commerce. 'There is (it says) a closely knit scheme of work, which rests, on the one hand, in university schools of botany, and, on the other, in commercial stores scattered all over the country, where accurate records of results and conditions have been kept, and extends to the conditions of transport by ship, and overseas so far even as the Australian orchards.' Other directions of research which touch upon commonplaces of our daily life are those concerned with fuel, with illumination, with the deterioration of fabrics and the fading of coloured stuffs, and—perhaps most homely example of all—with the application of scientific methods in the laundry industry.

This attitude of the State toward Science makes for an easing of the paths for the advancement of science in many directions; it marks a definite step in human progress, taken after long hesitation, but in itself new; and because it is new, we may believe with some reason that we live, not merely in an age of science. but at the beginning of it. The movement for co-operation which we have been discussing is not confined to this country. It has borne fine fruit already in other lands; and in particular it is active in our own Dominions. The Indian Empire stands in a somewhat different category from these : there is here a tradition, so to say, for the application of science in its government, and the scientific results of its census investigations, its surveys, its agricultural, forestry, and other administrative departments have long been famous. This is not to imply that brilliant scientific work has been wanting in the Dominions—far from it—but the co-operative movements with their governments have followed that in this country and with a laudable promptitude. The trend of developments following upon all these movements has been similar broadly speaking; it is sought to take a comprehensive survey of the natural resources and industrial opportunities of each Dominion, to explore the means by which Science may be best applied to their exploitation, to provide, whether in State institutions or in university and other labotities, for the pursuit of the necessary researches, to coordinate the work, and to ensure the dissemination of knowledge acquired.

It is impossible in the Imperial connection to overstate the case for science. Sir William Huggins, in his Presidential Address to the Royal Society in 1901, said that 'assuredly not only the prosperity, but even the existence of this Empire will be found to depend upon the more complete application of scientific knowledge and methods to every department of industrial and national activity.' To-day we see that application in much fuller progress than when Huggins spoke only a quarter of a century ago, and already we know how truly he prophesied.

There are parallels in many respects, as has been often pointed out and as often forgotten, between the periods of our history following the Napoleonic Wars and the Great War. The application of science in industry and daily life received impetus in the earlier of these periods in such directions as the introduction of steam motive power; it is receiving it now, as it has been attempted here to show. The auspices now are more favourable. Science is more powerful. Men more adequately and more generally recognise its power, and therein should lie a certain ethical value for it as offering a new point of view, in the manifold interest of which all can share. Should not the application of science, for instance, offer a new field for community of interest, not only between one industrial organisation and another, but within the whole body of workers in any single organisation? But in order that the community may fully realise all that it owes, and all that it might owe, to the advancement of science, the channels of communication between research and the public mind have to be kept clear, maintained and widened. The non-scientific public is accustomed to view science as it might view a volcano; prepared for the eruption of some new discovery from time to time, but accepting the effects of the eruption without realising the processes which led up to it during the preceding period of quiescence. The period of preparation by research before science can offer the world some new benefit may be long, but the scientific machine is always running quietly in the laboratory. There is an example ready to our hands. We recall the introduction of wireless telegraphy and telephony as a scientific gift of quite recent years. Do we all realise that it was here in Oxford, at the meeting of the British Association so long ago as 1894, that the first

public demonstration of wireless signalling by means of electro-magnetic waves was given by Sir Oliver Lodge? It was the work of science to develop the methods then demonstrated until they have been brought to their present marvellous uses. On the other hand it is often the case, whether in industrial or agricultural, domestic or whatever application, that science has knowledge at command, awaiting use, long before mankind can be brought actually to apply it. Though we have quickened, we are not yet so quick in the uptake of the results of applied scientific research as, for instance, some of our commercial competitors. The public support of scientific research, upon all these grounds, should be accorded freely, with understanding, and with patience.

This brings me, Ladies and Gentlemen, to the close of what I have to say to you this evening. From my opening remarks, you will have gathered that I looked on you as an extremely formidable audience. That was when I only knew you, so to speak, on paper. Now that I have met some of you face to face—and hope to meet others in the Town Hall in a few minutes—I can only say that, if the Presidential Address has not the traditional weight of knowledge behind it, no President in the history of the Association has ever received a more kindly and sympathetic welcome than you have given me to-night. I am deeply grateful for it.

One more duty remains to me—a duty to our hosts and to our guests. The University and City of Oxford have received us all with a high hospitality worthy of this town, to which all who have known it in the past always return with delight, and which never fails to throw its spell on those who see it for the first time. Their friendly reception has made it possible for those who have worked so hard at the organisation of this meeting to bring it to the successful culmination which it promises to attain. Not the least successful feature of it is the large number of distinguished guests whom it has attracted from overseas. To all of these I wish to offer a most cordial welcome with the sincere hope that they may always carry with them, as I shall myself, the most pleasant recollections of a memorable gathering."

ON THE SPECIFIC HEAT OF IRON-NICKEL ALLOYS.

By Mauso Kawakami.

(*Scientific Papers, Tohoku Imperial University.*)

Up to the present time, there have been few investigations of the specific heat of alloys; as to the specific heat of iron-nickel alloys, we have only an investigation by W. Brown. According to his result the specific heat is increased by 0.38 per cent. by adding one per cent. of nickel to iron in the range with a 0-4 per cent. of nickel content: between 4-10 per cent. contents, its variation is small, and from a 20-30 per cent. content the specific heat increases to 0.5 per cent. It is well known that the specific heat of metals varies with the heat treatment in no inconsiderable degree; but this dependency has not yet been completely determined. The present investigation was therefore undertaken to determine accurately the specific heat of iron-nickel alloys subjected to the following varieties of heat treatment :—

1. Normalized at 900°;
2. Normalized and then cooled in liquid air;
3. Quenched in water from 1,000°.

PRESIDENTIAL ADDRESS BY THE ASTRONOMER ROYAL.

(Sir Frank Dyson, M.A., LL.D., F.R.S.)

The Astronomer Royal of Great Britain, in his Presidential Address to the Optical Convention, 1926, recently held at the Imperial College of Science, London, reviewed the progress of optical manufacture in Britain and added tome remarks on the contributions of astronomers to the art of optical design.

From 1848 to the early eighties England occupied a dominating position in the manufacture of optical glass, but the challenge of Jena produced a temporary eclipse of such importance that in 1912 Britain imported 60 per cent. of her glass from Germany, 30 per cent. from France, and made only 10 per cent. at home. The outbreak of the war revolutionised this situation. The Institute of Chemistry initiated research upon glass manufacture so successfully that by 1917 the required formulæ had been found and, thanks mainly to the work of Sir Herbert Jackson, adequate supplies were made available for Britain and her

allies. In 1918 nearly 9 tons of optical glass were being produced per month, and opticians can now obtain from British sources all the glass they require.

The war also led to great developments in range-finders, which find a use in peace-time for surveying and navigation; in lenses for aerial survey, and other instruments. British made prismatic binoculars, which before the war were inferior to those from Germany, now hold their own with any in the world (and in particular offer a wider angle of view than any others).

The present progressive state of optical manufacture in Britain may be attributed to improved facilities for technical education, particularly at the Imperial College of Science; to the research and testing work carried on at the National Physical Laboratory, which supplies a constant stimulus to a high standard of achievement; to the Optical Society, which brings together manufacturers, theoretical opticians, astronomers and physicists; and to the British Scientific Instrument Research Association.

Turning to his own branch of science, the Astronomer Royal mentioned that a British worker, Gascoigne (who was killed in the Battle of Marston Moor in 1646), first invented the use of cross-wires in the telescope. The achromatic objective was due to another English scientist, Dollond, and the manufacture of these lenses became a British monopoly until it was killed by the glass tax. The removal of this tax in the middle of the 19th century led, however, to a revival of the industry. Telescope objectves increased in size until a 40-inch glass was made in 1897; and a 41-inch objective, an entirely British product, is now being made for the Russian Government.

As regards reflecting telescopes, Sir Isaac Newton shewed how to grind mirrors for this purpose; Hadley introduced the parabolic figure; Herschel made enormous improvements in the general design of the instruments; and Dr. Common and Sir Howard Grubb developed the silvered glass mirror. The lenses employed for stellar photography in England, the United States, South Africa and Australia are of British manufacture; and an amateur astronomer, Franklin Adams, having commissioned an English optician to design a suitable lens, has photographed the whole sky in 206 exposures, shewing stars one million times as faint as those of the first magnitude.

The development of the spectroscope owes much to Huggins and Lockyer in England, while the echelon spectroscope is made only in this country.

INSOLUBLE ANODES FOR THE ELECTROLYSIS OF BRINE.

By Colin G. Fink and Li Chi Pan.

(*American Electro-Chemical Society.*)

The development of the anode for the commercial alkali-chlorine cell is reviewed. After a careful study of the conditions prevailing in such a cell, a set of specifications for the anode material is drawn up. A number of materials, such as graphite, platinum, magnetite, carborundum, ferrosilicon, lead peroxide, manganese dioxide and natural anthracite have een considered, but proved not entirely satisfactory. Selecting those metals that form insoluble chlorides, alloys of silver-lead, mercury-lead, silver-lead-mercury, and silver-lead- manganese were prepared, and tested under specific conditions approaching the operating conditions of the modern alkali-chlorine cells.

The most important result herewith recorded is that, although the rate of anodic corrosion of pure silver or of pure lead or of pure mercury is very high, the rate of anodic corrosion—and with it the cell voltage—drops instantly upon the addition of a small percentage of silver to lead or *vice versa*. Our chemical and microscopic investigations show that this sharp reduction in anodic corrosion is due to the formation of a protective film over the surface of the anode, by the action of the anolyte on the metal constituents. The mechanism of film formation and its protective action was carefully studied, and is discussed at length. Metallographic studies were made of all alloys tested, in order to help solve the problems of anodic corrosion and its prevention.

Alloys of mercury and lead do not show the characteristic sharp drop in corrosion in the case of Ag-Pb alloys. On the contrary, a small amount of mercury in the Ag-Pb alloys greatly increases the corrodibility of the alloys. Likewise, the presence of manganese increases the corrodibility of Ag-Pb alloys in the NaCl anolyte. Attempts to make anodes using PbO_2 as the principal constituent were unsuccessful. The formation of anode film by special preliminary processes proved to be unsatisfactory.

The best anode alloy so far encountered consists of 61 per cent. Ag and 39 per cent. Pb by weight. Using anodes of this alloy, the effect of each of the operating variables, such as current density ,was separately and quantitatively determined. From the results obtained, a set of operating conditions was worked out, with practically no loss in weight of the anode. Accordingly, an alkali-chlorine cell using Ag-Pb anodes is designed, in which the production of pure alkali and chlorine, prolonged life of diaphragms and anodes, and high operating efficiency, seem assured with a saving of expense, floor space and labour.

CHEMICAL SOCIETY'S LIBRARY.

The Library of the Chemical Society will be closed for stocktaking from Monday, August 2, until Saturday, August 14, inclusive, and will close each evening at 5 o'clock from August 16 to September 11.

General Notes.

MANITOBA MINES ACQUIRED BY BRITISH COMPANY.

Messrs. John Taylor & Sons, of London, one of the Oldest and largest gold-mining companies of the world, have definitely entered the Lake Winnipeg mining area. According to the official announcement made, negotiations have been closed for the amalgamation of the Central Manitoba Mines, Ltd., Anglo-Canadian Explorers, Ltd., and properties of the W.A.D. Syndicate. Application has been made for a Manitoba Charter. Development work is to be immediately undertaken, and according to Mr. T. C. Anderson, Vice-President of the Central Manitoba Mines, construction of a modern mill will be started this winter.

WINNIPEG FORMS CHAMBER OF MINES.

Progress in the formation of the Winnipeg Chamber of Mines was reported at the meeting of the Executive held recently.

The idea behind the new organisation is to form a centre which can offer all possible assistance to mining companies and prospectors who intend to enter the Manitoba mining fields.

The Bureau will also be a receiving centre for mining news of a reliable kind, which will carry with it the weight of responsible opinion.

BRITISH FOOD MANUFACTURERS' RESEARCH ASSOCIATION.

The Secretary of the Department of Scientific & Industrial Research announces that a license, under Section 20 of the Companies' (Consolidation) Act, 1908, has been issued by the Board of Trade to the British Food Manufacturers' Research Association which has been approved by the Department as complying with the conditions laid down in the Government Scheme for the encouragement of industrial research.

FIND SPEED OF THE BLOOD.

For the first time in history, scientists are able to measure exactly how fast the blood flows through the body. This achievement was announced recently by Doctors Herman Blumgart and Soma Weiss of the Thorndyke Laboratory, Boston City Hospital, who declare it will be of valuable aid in determining abnormal conditions, particularly heart disease.

By their method, radium is injected in the left arm of a patient. Carried in the blood stream through heart and lungs, its arrival in the right arm is detected by an electroscope.

For the normal person the average speed of the blood over this course is from fifteen to twenty-two seconds, the doctors report; for a diseased person it is as slow as forty-five to sixty seconds.

—*Popular Science Monthly.*

TESTING BRITISH LENSES.

One of the most interesting exhibits at the Optical Convention, 1926, recently held in London, was the massive "Universal Lens Interferometer" which is used at the National Physical Laboratory for testing the quality of camera lenses. This carries a stage further the interferometric equipment of the laboratory for testing optical work. (This equipment will be completed this year by the addition of a microscope interferometer.)

No other country in the world possesses

such an accurate and efficient apparatus for testing camera lenses as the one in question. The apparatus makes use of the fact that any irregularity in a lens has its effect on the time taken by the light to reach any point of the image. A beam of light, consisting usually of parallel rays, is divided into two parts by a half-silvered mirror; one of these parts is reflected back by a plane mirror through the half-silvered mirror and into the observer's eyepiece; the second part passes throngh the lens under test and therefore converges towards the focus of that lens, but is intercepted and reflected back, as if coming from the focus, by an accurately worked spherical mirror whose centre is at the focus. It thus passes through the lens under test a second time, falls upon the salf-silvered mirror, and is reflected thereby into the eyepiece, where it interferes with the first part of the divided beam. The distribution of interference bands produced enables an experienced observer to diagnose at once any defects which may be present in the lens.

By means of an ingenious linkwork mechanism, the test is applicable not only to beams parallel to the axis of the lens, but also to oblique beams; and further elaboration of the linkwork enables the tests to be extended to telephoto lenses under all conditions, and to a system whereby light proceeds from a point source as distinct from a parallel beam (as in the case of the lenses nsed for process work). It is scarcely possible to exaggerate the importance to the British optical industry of the high standard of optical testing provided for its guidance at the National Physical Laboratory.

NOTICES OF BOOKS.

A Method of Trapping the Dust Produced by Pneumatic Rock Drills. By P. S. HAY. (Safety in Mines Research Board Paper No. 23, H.M. Stationery Office, Adastral House, Kingsway, London, W.C.2. Price 6d. net).

Long-continued inhalation of air containing certain varieties of dust consisting largely of crystalline quartz is liable to cause miners' phthisis. In mining operations such dust is associated particularly with mechanical drilling in ganister or hard sandstone, or in granite. A water-jet or spray is the means generally in use in this country for preventing the dissemination of drill-dust into the mine atmosphere, but this method is not altogether satisfactory, and the problem of devising alternative means was undertaken by the Safety in Mines Research Board, their investigator, Mr. P. S. Hay, receiving assistance from Dr. Pirow, of the South African Mines Department. The results are described in the paper.

It contains a description of an apparatus by means of which the dust produced in the drill hole is collected by a hood and conveyed by means of an ejector, operated by the exhaust air from the drill, to a filter bag, where the dust is intercepted and the filtered air passes out through the interstices of the material of the bag. The apparatus has been submitted to pit trials under working conditions with satisfactory results.

There is a preface to the paper by Professor J. S. Haldane, Chairman of the Health Advisory Committee of the Mines Department.

FRAGMENTS RELATING TO THE HISTORY OF CHEMISTRY IN AMERICA.

This is the title of a readable article by Prof .Edgar F .Smith, University of Pennsylvania (reprinted from the *Journal of Chemical Education*, Vol. 3, No. 6). Brief summaries of early American chemists are given, Dr. Lyman Spalding, Joseph Priestly, The Winthrops, John W. Webster, Amos Eaton ,and others. These are not great names in chemical history, but they are pioneers who in their day and generation did their part in promoting chemical knowledge.

Messrs. Henry Southeran & Co., have just issued their *Catalogue* (No. 800) of *Science and Technology No. III.* An Annotated and Classified List of Rare and Standard Works on Exact and Applied Science. Part VII., Chemistry and Chemical Technology. Price 2s. 6d. Pp. 633-840. The books are systematically arranged according to subjects and are in alphabetical order under " Authors."

Practical Glass Manufacture. By DENNIS BROOK BRIGGS, M.A., etc., Science Master at Bradford College.

This is one of Lockwood's useful manuals. It extends to some 54 pages, is well illustrated, and might justly be called a *multum in parvo* on the subject of glass manufacture. A list of the apparatus required is given in illustrated form.

A Manual of Radioactivity. By GEORGE HEVESY, Ph.D., Copenhagen, AND FRITZ PANETH, Ph.D., Berlin. Translated by Robert W. Lawson, D.Sc., F.Inst.P. Oxford University Press.

Radioactivity occupies a large place in both the lay and scientific mind, and the present work (which we are told frankly in the preface to the English edition, is not a literal translation) aims at meeting the requirements of the student of the subject. The authors and translator have well succeeded in their efforts, and especially as there are embodied the results of research work on radioactivity up to last year. The book is well printed and handsomely bound, and extends to XX + 252 pp.

Practical Physiological Chemistry. By S. W. COLE, M.A. (University Lecturer in Medical Chemistry, Cambridge). XII + 482. Price 16s. net. Cambridge: Heffer & Sons, Ltd.

The fact that the present issue is the seventh edition is evidence of the popularity of this work. It has been enlarged and brought up to date. There has been added a new chapter on Biological Oxidations and Reductions, as also one on Blood Analysis. It is claimed that the work has been proved a success in the large classes at Cambridge. There are many useful illustrations and an extended index and several pages of contents.

Geology and Economic Minerals of Canada. By DR. G. A. YOUNG.

The Canadian Geological Survey has published a revised edition of this work. Although the author makes for it no more ambitious claim than that it is intended to serve as an introduction to the study of the subject, the reader is amazed and delighted with the great amount of detailed information that has been condensed in readable style into about two hundred and fifty pages of octavo size. It represents an approximate estimate of our knowledge of the geology and mineral possibilities of the country, a survey of the whole field by one who is eminently qualified for the task. It sets forth concisely the present status of the subject and does indeed serve admirably as an introduction to an intensive study of the geology and mineral wealth of Canada. It serves also as a presentation quite adequate to the needs of anyone who is desirous of obtaining a good knowledge of the geology of the whole country, but whose interests do not extend to minute details in any particular phase. The report is well illustrated by judiciously selected photographs and is accompanied by two maps. Copies may be had on application to the Director, Geological Survey, Ottawa, or the Natural Resources and Industrial Information Bureau, The Canadian Building, Trafalgar Square, London, S.W.1.

The Preparation and Analysis of Organic Compounds. By J. BERNARD COLEMAN A.R.C.S. (Dublin), AND FRANCIS ARNALL Ph.D. (London). Pp. XVI + 352. price 15s. London: J. & A. Churchill.

The work is composed of five sections, and the authors give numerous experiments and directions, which will prove both helpful and interesting to students. The analysis is both qualitative and quantitative. The book deserves widespread appreciation.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

17,872.—Boot's Pure Drug Co., Ltd.—Manufacture of alkyl resorcinols. July 16th.

17,657.—Buchner, M. — Manufacture of hydrofluoric acid. July 14th.

17,561.—Gluckmann, E.—Manufacture of an aqueous emulsion of paraffins. July 13th.

17,655.—Soc. of Chemical Industry in Basle.—Manufacture of dyestuffs. July, 13th.

17,570.—Thomson, R. F.—Manufacture of dyestuffs, etc. July 13th.

Specifications Published.

254,760.—Badische Anilin & Soda Fabrik.—Manufacture and production of oxygenated organic compounds.

254,819.—Badische Anilin & Soda Fabrik.—Synthesis of organic compounds.

254,888.—Regal, A.—Process for the manufacture of artificial resins.

240,424.—Kendall, S. W.—Process and apparatus for the production of pigments from sulphide ores.

215,765.—I. G. Farbenindustrie Akt-Ges. Manufacture of new azo-dyestuffs.

Printed Copies of the full Published Specification may be obtained from the Patent Office, 25 ,Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

Abstract Published.

252,099.—Synthetic drugs.—Stickings, R. W. E., The Rowans, Ravensbury Park, Mitcham, Surrey; and May & Baker, Ltd., Garden Wharf, Church Road, Battersea, London.

Piperazine salts of substituted phenylarsinic acids are prepared by interaction of the acids with piperazine. The combination is preferably effected in the presence of a solvent such as water or alcohol, from which, if desired, the salt is isolated by crystallisation or precipitation. The salts, which are water-soluble, possess therapeutic properties. Examples are given of the preparation of the piperazine salts of *p*-oxy-*m*-aminophenylarsinic acid, *p*-aminophenylarsinic acid, *p*-oxy-*m*-acetylaminophenylarsinic acid and N-phenylglycineamide-*p*-arsinic acid.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

STERULES.

469,165.—Chemical substances used for veterinary and sanitary purposes, but not including soil sterilizers and insecticides, or the like.—W. Martindale, 10, New Cavendish Street, London, W.1. July 21st.

AUKLO.

470,547.—Chemical substances used for veterinary and sanitary purposes. —John William Anckland, Cliffe Side, Shepley, near Huddersfield, Yorkshire.

HYPONOID.

470,319.—Chemical substances prepared for use in medicine and pharmacy. —J. Richardson & Co, Leicester, Ltd., 10, Friar Lane, Leicester. July 21st.

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Three copies each of the following numbers of the *Chemical News* wanted :—

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THE LAW OF RELATIVE VOLUME (*Continued*).

THE PART-VOLUME 5.02.

By HAWKSWORTH COLLINS, B.A. (Camb.).

The volume 5.02 occurs more often than any other in the demonstration of the laws of heat of formation and relative volume, and it always represents the volume of a tetrad.

This is a matter which could not possibly have been foreseen by anyone, much less could it have been hypothesised. It is a proof that the laws are correct, because it is a definite discovery obtained unexpectedly from previous discoveries.

In other words, the laws of heat of formation and relative volume are two regularities. If these regularities are only imaginary, and not real, *i.e.*, if they are merely the result of juggling with figures, it would be impossible to discover any other regularity within them. A regularity can only be discovered within a regularity if the latter is real and not imaginary.

The numbers in the last columns of the Tables refer to substances in this and the two preceding papers.

Table XVI. gives the cases in which two volumes of the same element differ by 5.02. columns of the Periodic Table. (The column containing the gases of zero-valency does not come into the matter.) The probability that any one of them would be an element which happens to come in one of these two columns is 2 : 7. Therefore, the probability that all seven would accidentally be elements which come in these two columns is $2^7 : 7^7 = 1 : 6434$.

This is supposing there are only seven columns. If there are nine, not including the zero-column, the probability against its happening by accident would be more than 70,000 : 1.

This is another regularity appearing within a regularity, and is therefore another proof that the law is correct.

The reason why these elements must come in the higher columns is evident from preceding papers, but cannot be discussed now.

The first four in the Table are the only ones whose structures have so far been demonstrated in the *Chemical News*, and in each case 5.02 has been shown to be the volume of a tetradic portion of the element, *viz.* :—

$$H_3 + H + H_3 + H$$

so it is possible that scientists may trust the statement that when an opportunity occurs

TABLE XVI.

		Volumes				Difference.	Refer to Nos.
(248)	Oxygen	7.53	-	2.51	=	5.02	80, etc.
(240)	Sulphur	15.53	-	10.51	=	5.02	93, 74.
(250)	Iodine	32.77	-	27.75	=	5.02	148, 150.

(251)	Selenium	21.29	-	16.27	=	5.02	284, 285.
(252)	Bromine	23.09	-	18.07	=	5.02	237, 286.
(253)	Neodym	20.60	-	15.58	=	5.02	287, 288.
(254)	Fluorine	20.72	-	15.70	=	5. 02	

(These last volumes will be supported when an opportunity occurs of demonstrating the structure of an atom of fluorine.)

In addition to the fact that the above elements have each two volumes differing by 5.02, it is a fact that all these seven elements are in either the sixth or seventh of demonstrating the structures of the remainng three elements in the Table, the 5.02 will be shown to be due to the same cause.

Table XVII gives the cases in which two similar elements differ in volume by 5.02 or 2(5.02) at 15° C.

TABLE XVII.

	Atomic Weights.	Vols.	Refer to Nos.
(255)	136(Ba) = 40(Ca) + 96(Ti_2)	35.70 = 25.66 + 2(5.02)	120, 113.
(256)	136(Ba) = 40(Ca) + 96(Ti_2)	24.58 = 14.54 + 2(5.02)	121, 88.
(257)	88(Sr) = 40(Ca) + 48(Ti)	30.68 = 25.66 + 5.02	122, 113.
(258)	88(Sr) = 40(Ca) + 48(Ti)	19.56 = 14.54 + 5.02	123, 88.
(259)	128(Te) = 32(S) + 96(Ti_2)	20.55 = 10.51 + 2(5.02)	126, 74.
(260)	128(Te) = 32(S) + 96(Ti_2)	17.55 = 7.51 + 2(5.02)	129, 130.
(261)	28(Si) = 12(C) + 16	13.02 = 8.0 + 5.02	108, 87.
(262)	75(As) = 31(P) + 44	19.58 = 14.56 + 5.02	289, 145.
(263)	118(Sn) = 28(Si) + 90(Zr)	18.04 = 13.02 + 5.02	160, 108.
(264)	118(Sn) = 28(Si) + 90(Zr)	16.55 = 11.53 + 5.02	161, 94.

In addition to the fact that these pairs of elements differ in volume by 5.02 or 2(5.02), it is a fact that in each case of the six pairs of elements in this Table thetwo concerned are in the same column of the Periodic Table. The probability against this happening by accident is evidently enormous.

This is another regularity which affords an additional proof that the matter is correct.

TABLE XVIII.

Other Cases in Which 5.02 Occurs.

	Atomic Weights.	Vols.	Refer to Nos.
(265)	136(Ba) = 40(Ca) + 96(Ti_2)	29.00 = 14.54 + 9.44 + 5.02	127, 88, 111.
(266)	138(Ce) = 63(Cu) + 27(Al) + 48(Ti)	21.20 = 7.13 + 9.05 + 5.02	128, 110, 82.
(267)	138(Ce) = 63(Cu) + 27(Al) + 48(Ti)	17.83 = 9.07 + 3.74 + 5.02	290, 223, 49.
(268)	138(Ce) = 63(Cu) + 27(Al) + 48(Ti)	19.30 = 5.23 + 9.05 + 5.02	291, 163, 82.
(269)	182(Ta) = 94(Cb) + 40(Ca) + 48(Ti)	17.75 = 8.82 + 3.91 + 5.02	155, 50.

where Cb = Na_2Ti, 94 = 2(23) + 48, and 8.82 = 2(1.9) + 5.02.

(270)	182(Ta) = 94(Cb) + 40(Ca) + 48(Ti)	22.17 = 8.82 + 3.91 + 9.44	154, 111.
(271)	141(Pr) = 90(Zr) + 24(Mg) + 27(Al)	21.58 = 5.02 + 7.51 + 9.05	162, 163, 82.
(272)	138(La) = 90(Zr) + 48(Mg_2)	22.24 = 5.02 + 2(8.71)	164, 81.
(273)	138(La) = 63(Cu) + 27(Al) + 48(Ti)	19.30 = 5.23 + 9.05 + 5.02	292, 163, 82.
(274)	31(P) = 23(Na) + 8.0	14.56 = 9.54 + 5.02	145, 38, 87.
(275)	59(Ni) = 28(Si) + 31(P)	5.02 = 5.02 + 0	280.
(276)	59(Ni) = 28(Si) + 31(P)	19.58 = 5.02 + 14.56	282, 145.
(277)	104(Pd) = 56(Fe) + 48(Ti)	15.10 = 10.08 + 5.02	124, 125.
(278)	44(Sc) = 12(C) + 32	13.02 = 8.0 + 5.02	283, 87.

The masses which have been demonstrated above to have the volume 5.02 are 8, 16, 28, 32, 44, 48, and 90. The last is recognised as a tetrad and has never been suspected of being anything else. It is far away in the region of the heavier elements.

The simpler elements end at 51(V), because this is the last (in the order of ascending atomic weight) whose at. wt. can be split up in the manner frequently demonstrated in the *Chem. News* for the simple elements, *viz.*,

$$Na + H + Na + H + H_3$$

i.e., with H as the connecting link between the parts, which are arranged in descending order of magnitude. In addition to this there must be five parts if the element is a pentad; and there must also be a helium-portion $H + H_3$, if the element is a non-metal as vanadium is.

The simple elements are defined by the Fourth Main Principle in the Constitution and Structure of the Chemical Elements. There are five main principles as previously demonstrated in the *Chemical News*, 1920, CXXI., 182; but to make the present matter intelligible it is necessary to restate them here.

(i) Single chemical valences emanate from elements or portions (of elements) whose masses are 1, 3, 7, 23, and 39.

(ii) The non-metallic nature of an element is always due to a pair or pairs of electro-positive forces, each pair emanating from a portion of the element, of which the mass is 4, taking the mass of an atom of hydrogen as unit.

(iii) Monadic Na (23) takes a prominent part in the formation of all elements of greater mass than itself.

(iv) In the simpler elements H (1) forms the connecting link between the other portions 3, 7, 23 and 39. In the formation of the heavier elements, masses of 23 sometimes unite by forces, which are not chemically evident, without any intervening unit mass.

(v) Each of the heavier elements is formed by the union of simpler elements.

From (i) and (iv) the only masses under 53 which can form tetrads are therefore :—

$$3 + 1 + 3 + 1 = 8$$
$$7 + 1 + 3 + 1 = 12$$
$$7 + 1 + 7 + 1 = 16$$
$$23 + 1 + 3 + 1 = 28$$
$$23 + 1 + 7 + 1 = 32$$
$$23 + 1 + 23 + 1 = 48$$
$$39 + 1 + 3 + 1 = 44$$
$$39 + 1 + 7 + 1 = 48$$

All except one of these coincide exactly with the numbers mentioned above. The exception will probably be brought in later.

TABLE XIX.

Substances employed above, additional to those in Table IX.

	Relative Volume.	Theor. S.G. at 15°	Obs. S.G.	
(280)	NiP_2 5.02 + 2(10.51)	4.65	4.62	18°/4 Interntl.
(281)	NiP_3 5.02 + 3(10.51)	4.16	4.19	18°/4 Interntl.
(282)	$NiBr_2.6NH_3$ 19.58 + 2(23.09) + 6(18.11)	1.84	1.837	Topsoe
(283)	Sc_2O_3 2(13.02) + 4.45 + 2(2.51)	3,83	3.8	Cleve
			3.864	Nilson
(284)	SeS 21.29 + 15.53	3.0	3.056	0° Little *i.e.*, 3.02 15°
(285)	Se 16.27	4.794	4.796	Schaffgotsch
(286)	$PbBr_2$ 19.44 + 2(18.07)	6.59	6.61	18° Kremers
			6.572	19°.2 Keck
(287)	Nd 20.6	7.00	6.96	Baskerville
(288)	$NdCl_3$ 15.58 + 3(15.085)	4.135	4.134	25°/4 Nostrand
(289)	As_2S_3 2(19.58) + 3(10.51)	3.480	3.48	Haidinger
(290)	$CeCl_3$ 17.83 + 3(15.085)	3.88	3.88	15°.5 Nostrand
(291)	Ce_2O_3 2(19.3)+ 3(2.51)	7.02	7.0	Nostrand
(292)	$LaCl_3$ 19.3 + 3(1[illegible]	[illegible]	3.79	0°/4 Interntl.

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SECTION B—CHEMISTRY.

THE SCOPE OF ORGANIC CHEMISTRY.

ADDRESS BY PROFESSOR J. F. THORPE, C.B.E., D.Sc., PH.D., F.R.S.
PRESIDENT OF THE SECTION.

The chemistry of the compounds of carbon covers a wide field, wider than that covered by any other element. Its scope embraces all living matter, as well as the vast number of non-living substances which are produced through the agency of life. Moreover, it includes a very great number of compounds unrelated to life or to living processes which have been built up by the *chemist in the laboratory by methods he* has divised.

Already some 200,000 definite compounds have been tabulated in Richter's Lexicon and in the supplements thereto, and this number is increased yearly by several thousands through the agency of a band of zealous workers scattered over the globe. It may well be asked what is the good of continuing to increase this already astonishing number; and is the expenditure of time, labour and energy justified which lead to the discovery of some new fact having, apparently, no useful application to any department of human activity? The answers to these questions are quite clear and definite. You must acquire a knowledge of the simple before you can attack the complex with any hope of success. The element carbon has been used by nature as the basis of organised life because the capacity of carbon to combine with itself is shared by no other element, and it is upon this capacity that nature has relied in order to build up the tissues and reserve materials which form the living world around us. Moreover, since the compounds of carbon containing a moderate number of atoms of the element are usually crystalline or capable of becoming crystalline, and there are obvious disadvantages attaching to the use of potentially crystalline substances as the basis of living matter, it has been found necessary to employ the more complex carbon derivatives containing many hundreds of elemental atoms, which by reason of their high molecular complexities no longer possess, or seem capable of acquiring, a crystalline structure, but belong to the class of jelly-like or colloidal substances. Until we can determine how a small number of carbon atoms combine one with the other we cannot hope to obtain any insight into the manner in which the more complex natural substances are built up, or any information regarding the way in which they *are utilised to bring about the changes* occurring during animal and vegetable metabolism.

STRUCTURE.

The science of structural organic chemistry is only just fifty years old. It was born when the genius of van't Hof gave to the world the clue upon which the three dimensional formula we now use is based. It is, therefore, no inconsiderable achievement to have gained in so short a time a knowledge of many of the reactions and properties of the more simple complexes of carbon in combination with oxygen, nitrogen and other elements. But much yet remains to be done before we can attack with any real hope of success the problems which the chemistry of nature presents. It is true that the knowledge already gained has led to the synthetic preparation of quite a number of natural products, many of which are of service in relation to human needs. Many of the alkaloids, colouring matters like indigo and alizarine, camphor, and a large number of natural products, have yielded the secrets of their structures and have been produced by laboratory methods and, where necessary, on the factory scale. But the snythesis of such compounds has not provided much insight into the mechanism leading to their production in nature, and indeed the reason for their occurrence in the plant is not understood. They are, moreover, crystalline substances which either occur in the plant as such or are formed by the hydrolytic fission of some more complex plant materials,

Their homogeneity is, therefore, not open to doubt, and their degradation into known fragments and the rebuilding of these fragments into the original substances, although by no means easy, is nevertheless comparatively simple when the difficulties attending the investigation of more complex natural products are taken into account. Even so, some of the simpler type, for example, strychnine, still resist the attack of the chemist.

The Electronic Theory.

It is clear that our knowledge of the finer mechanism of reactions is slight, and that great as has been the advance made through the discovery of van't Hof, we are still at a loss to explain or predict the shades which determine whether one particular type of reaction will be more, or less, facile than another. The chief trouble seems to be that the electronic theories, which are quite satisfactory in themselves, are not yet developed so fully that they can include any quantitative statement relating to the changes in the free energy of systems. Yet it is evident that any theory of organic structure must conform to the modern physical conceptions of matter. The principle of shared electrons is primarily justified by its success in explaining the linking of atoms, i.e., valency, and by its successful interpretation of the theory of co-ordination and 'onium' salt formation. The subsidiary hypothesis of electron displacement also provides a means by which an explanation can be supplied to account for the ease of formation, stability, and general reactions of conjugated systems, thus placing the hypothesis of Thiele on a sounder theoretical basis.

We have now succeeded in isolating cis-hexatriene, and are studying the action of bromine on it. If, as is to be anticipated, the addition takes place in the 1 : 6 positions, direct evidence will be available in favour of the electronic hypothesis. The work is, however, exceedingly difficult because, unlike those of the trans series, the cis compounds are liquids and therefore difficult to identify. Moreover, they are unstable and readily polymerise to resins on keeping. There is no doubt, however, that these difficulties will be overcome.

There can be no question that the distribution of electrons among the carbon atoms and other atoms of organic molecules must determine the reactions of the complexes involved, and future research will no doubt lead to an advance in our knowledge concerning the causes which promote or retard this distribution.

The ductility of the carbon to carbon bonds which have now been clearly demonstrated enables us to impart strains to certain parts of an organic molecule at will, and it is reasonable to assume that such strain when once set up will be shared as far as possible equally by all the atoms of the system involved. If this distribution is, as Robinson postulates, effected by a restricted flow of electrons from one atom to another in the molecule we have, at any rate, a definite picture of the process which the mind can grasp; and if the distribution leads ultimately—as is to be surmised—to the establishment of polar characteristics at different parts of the molecule, which will determine reactivity at those points, we are in a fair way to reconcile the views of various contending schools and to reach a general hypothesis acceptable to all chemists, and which may even satisfy the physicists. It seems that, despite the organic chemist's proneness and ability to distort the molecules with which he deals, nature has provided a means by which a certain degree of molecular equilibrium can be attained. Nevertheless it will be by the investigation of the conditions leading to the setting up of strain and of the effect produced thereby that we shall gain the most information regarding the chemistry of carbon structures in the near future. The course of a reaction in organic chemistry which involves an equation such as the following

$$CH_3.CH_2.CH_2Br + CHNa\begin{matrix}COO\ Et.\\ \\ COO\ Et.\end{matrix}$$

$$NaBr + etc.$$

is determined by the tendency to form NaBr —the organic residnes have to make the best they can of the situation, and the manner in which they will combine with themselves or react each with the solvent is dependent on the influence of many factors. Undoubtedly there will be a tendency to produce the most stable system and the one whose formation involves the greatest loss of free energy, but there must be a possible mechanism, and this involves the polar factors. Even these cannot force a group into a position in which there is no room for it, and therefore the effect of polarity must always be dependent on steric coudítions. No doubt polar conditions determine the order of priority of a number of possible

arrangements, but it is the steric condition that determines which of these arrangements shall be followed.

STRAINLESS SYSTEMS.

It is reasonable to assume that the organic substances that occur in nature as such are produced by means which involve the least expenditure of energy, and that they are, therefore, strainless. Among such natural products there are many containing carbon rings belonging to ring systems which cannot normally be produced without distorting the carbon tetrahedral angles of the component carbon atoms, and thus imparting intramolecular strain to the compounds formed. Nevertheless it is interesting to note the means adopted by nature to relieve this strain and thus to confer equilibrium and stability on quite unlikely ring systems. Ring systems stabilised in this way are found frequently among terpenes; two, namely camphor and pinene, need only be mentioned to illustrate the general method. In camphor the bridged ring is stabilised by the presence of two dimethyl groups, and in pinene, where the junction of the inner ring has to take effect in the position 3, the presence of a double bond on the shoulder of the external ring is necessary. Still more remarkable examples are afforded by more complex natural ring systems. For instance, there is a substance named civetone, which is extracted from certain glands of the Civet cat. There is no doubt as to its structure, which has been shown to contain a 17-membered ring, thus:—

$$\begin{array}{l} CH.(CH_2)_7 \\ \quad\| \qquad\qquad >CO \\ CH.(CH_2)_7 \end{array}$$

The evidence of structure being derived both from a study of the degradation products of the substance as well as by its recent synthesis.

BIOCHEMISTRY.

In its earliest days the science of organic chemistry dealt only with those compounds which were derived from natural sources, and it was regarded as certain that such substances could only be produced through the agency of life and by no other means. Since then this theory has been shown to be wrong by the preparation in the laboratory of many substances identical with those formed during the operation of life processes. Nevertheless, the more complex substances which nature utilises in building up her animal and vegetable structures still show no signs of yielding the secrets of their constitutions, or the mechanism by which they are produced. Indeed, although we can imitate in the laboratory certain natural operations such as the hydrolysis of starch to glucose, we are still quite ignorant of the means by which glucose is converted, by the appropriate enzyme, into alcohol and carbon dioxide, neither can we imitate this process in the laboratory.

When once the chemist has passed beyond the crystalline and the distillable he enters a region full of difficulties, because he has few means either of purifying the materials with which he has to deal, or of determining their homogeneity when they have been purified. These are the real difficulties which confront the biochemist when he approaches his subject from the structural side of organic chemistry. Biochemistry is in the unique position of being both a descriptive or observational science as well as one of the experimental sciences. From the biological side it has at its disposal the wealth of knowledge acquired by the physiologists and pathologists, and from the chemical side it is in touch with the recorded experience of several generations of organic chemists. If biochemistry is to justify its name it must carry out its function of bringing into line the discoveries of the physiologists with organic chemical structure, for by this means only will it be possible to gain an insight into the chemistry of natural processes which it is the object of biochemistry to discover. It is far from my object to disparage the wonderful work which has been done and is being done by physiologists and pathologists in their attack on the mechanism of normal and abnormal life processes. Their record speaks for itself. But too little is being done to approach the problems from the purely organic chemical side, and too few of tbe people engaged in biochemical research have an adequate knowledge of organic chemistry or the methods of the organic chemist. The number of organic chemists who are co-operating with biologists in their attack on natural processes is too few. Indeed, the very difficult question arises here as to how best to organise methods for dealing with problems which are essential border-land problems between two great sciences. I do not propose on this occasion to discuss the vexed question of the chemical engineer, but actually the analogy between this hybrid and the biochemist is fairly close. Is the

biochemist to be a biologist with a knowledge of chemistry, or is he to be a chemist with a knowledge of biology? I refer, of course to the method of training required for a man or woman who proposed to acquire sufficient acquaintance with both sciences to render him an effective worker in the borderland field, although here again the temperament which promotes enthusiasm for research in the experimental sciences and that which leads to initiative in the descriptive sciences is not usually found in the same individual. As knowledge increases the need for specialisation must also increase, because the time factor, that is the time during which it is possible for a student to undergo training, cannot be prolonged beyond a certain period. Even at the present time it is an open question whether it is possible to give a student a special training in more than one science and in the sciences subsidiary thereto in the time available, and this problem will become more acute as knowledge increases. It has been suggested that we should revert to the older method by which a student was instructed in, say, three sciences without any special training in any one of them, and doubtless this method was a good one for the requirements of those times. But the day of the universalist is past, and general scientific culture has become a luxury of the leisured classes. It is only by the aid of the specialist that, nowadays, we can hope to obtain advances in knowledge either in the sciences or in the sciences applied to industry.

It seems that the best method to attack problems in the borderland subjects is by co-operation between two types of trained investigators. In the case of biochemistry, for example, by the provision of trained students of two kinds, the one trained in physiology but with a sufficient knowledge of organic chemistry to promote sympathy with and knowledge of the chemists point of view, and the other trained as an organic chemist with a similar knowledge of the methods and requirements of the physiologist. The former would be a trained physiologist who would devote his final year to organic chemistry, the latter an organic chemist who would devote his final year to the study of physiology. This is, of course, no new idea, but is one which is being carried out in at least one institution in this country in connection with other borderland subjects. But it is the absence of any real attempt to approach biochemical problems from the chemical side that renders it particularly desirable that the need for some such scheme should be emphasised. It is true that the fault is largely on the side of the organic chemists who, for the most part, seem appalled by the difficulties attaching to the study of natural processes. The difficulties are indeed great, but not insurmountable. We are far from gaining any insight into the meaning of life, but it is not unlikely that we shall, in the near future, obtain some information regarding the mechanism of the action of the enzyme, the important agent in the non-living transformation of living matter into chemical products. It may be that organic chemists are waiting to see how Willstätter, who has already made great progress in enzyme chemistry, will surmount the difficulties confronting him, and it may well be that this great organic chemist will introduce new methods of attack which will open up fresh fields for investigation.

Analytical.

Except for the substitution of gas for charcoal, it cannot be said that the ordinary methods of analysis employed by the organic chemists have changed much since the days of Liebig. They have been modified, notably by Dennstedt, and more recently some have adopted the microchemical methods introduced by Pregl, but the older methods, for example, the long and tedious process for the examination of halogens by the method of Carius, are still in vogue in many of our laboratories and are taught to the students. In any case the usual operation entailed by the estimation of carbon and hydrogen, nitrogen and sulphur and the halogen require considerable time, which has not been materially shortened by the introduction of the less cumbersome methods due to Dennstedt. Pregl's methods, in which a very small quantity of material is used requiring the provision of a special type of balance, have been tried in many laboratories, and have found favour, it is understood, in several of them, more particularly abroad. But the general experience has been that the technical skill required to obtain good results is acquired only after long practice, and that whereas the methods are useful for obtaining an indication of structure when the quantities of material at hand are so small as to necessitate their use, yet when a sufficient quantity of substance is available the

older methods are more reliable and more easily carried out. It is interesting to note that the new methods which have been introduced by Prof. ter Meulen, of Delft, are going to be described to us by Prof. ter Meulen himself, who is fortunately with us at this meeting. Prof. ter Meulen will give an account of his methods on Tuesday morning, and they will be shown in actual operation during the soirée on Tuesday evening. Chemists will then see that a great saving of time can be effected by methods which can not only be used to analyse the small quantities employer by Pregl, but also quantities of 0.1 grm., such as organic chemists have been accustomed to use in the past, and which have been shown to produce the most accurate results.

THE UTILISATION OF FOREST PRODUCTS.

The immense number of organic compounds distributed among the plants, trees and grasses which form the forests and jungles of the world, offer a wide field for research which has still much to yield. Our knowledge of the medicinal properties of organic substances and the various uses to which they could be put in the service of mankind did not come to us through any effort of the chemist, but as the outcome of a process of trial and error which is as old as the human race itself. These products were obtained from vegetable materials present in the forests, and as time went on they were extracted in a form possessing some degree of purity, and the plants containing those with specially valuable properties were cultivated for their production. As soon as a theory of organic structure was evolved upon which prediction could be based, these useful products were subjected to close investigation, and in several cases they were prepared by laboratory means. As an outcome several of them, such as indigo and alizarine, were found to be capable of production more economically by the chemical method than by the processes of life, and the natural substances were rapidly replaced by the artificial products. Others still resist all efforts to unravel their structures, and remain still unsynthesised. Nevertheless it has been by a study of the chemical structure of natural products that much has been learnt regarding the relation between chemical composition and physiological action, and although it may not have been found possible economically to prepare the natural substance itself, the clue revealed by the determination of structure has led to the production of other substances which have not only shown the properties of the natural compound in an enhanced form, but have also exhibited other valuable physiological effects. The determination of structure has, therefore, two objects—to prepare the natural substance and to ascertain the particular arrangement of the atoms in the molecule which confers on it the properties which determine its value. The determination of the structure of indigo led not only to the production of the blue natural indigo, but enabled indigoes of every shade of the spectrum to be prepared as commercial products. The determination of the structure of cocaine revealed the molecular complex which conferred on this substance its power to act as a local anæsthetic, and has led to the production of a number of other substances possessing this valuable property but without the special disadvantages attaching to the use of the natural substance. Examples of this kind are numerous and should be increased. A systematic examination of our forest products would undoubtedly lead to the discovery of many others, and would provide opportunity for the investigation of many other important problems, such as, for example, the utilisation of forest grasses as a source of power alcohol.

Systematic team-work research by organic chemists in close association with botanists is required, and now that the Forest Production Research Board of the Department of Scientific and Indnstrial Research is in active operation, no doubt this branch of its work will receive attention.

SECTION A.—MATHEMATICAL AND PHYSICAL SCIENCE.

ABSTRACTS.

Quantitative Methods in X-ray Crystal Analysis. By PROF. W. L. BRAGG, F.R.S.

In investigations of crystal structure, it is assumed that waves in the X-ray region, scattered by the atoms of a crystal, obey the laws of interference which have proved capable of explaining diffraction in optical experiments. This assumption is justified by the success with which crystal structures of a simple type have been analysed. The strength or weakness of diffracted beams can be used in a very general and qualitative way to fix atomic positions with considerable accuracy.

Analysis may be made more precise by exact measurements of the ratio between the energy of radiation scattered by a crystal and the energy of incident beam. Evidence is accumulating that not only are the classical laws of interference obeyed, but that the amount of energy scattered by the electrons is given by the well-known electromagnetic equations. This assumption has now been tested for a large number of crystals.

Crystal analysis assumes quite a new aspect when precautions are taken to obtain reliable measurements of intensity of diffraction. The distribution of scattering matter (electron density) throughout the crystal, and surrounding the atoms, can be deduced from the results, and structures of a complex type can be analysed. Though it is possible with rough estimates of intensity to analyse crystals with five or six parameters, and this has been done in several cases, such analyses are tedious and somewhat uncertain. When exact measurements of intensity are available, crystals with a number of parameters expressed in double figures present no great difficulty. We seem to be within measurable distance of achieving the ideal position when the structure of a crystalline body can be deduced as directly from the X-ray data, for in so many other cases the classical laws give the right solution, although there is such strong evidence that their fundamental interpretation requires to be modified.

The Forces Between Ions and a Crystal. By DR. J. E. LENNARD-JONES.

The first step towards the correlation of the physica properties of crystals lies in the determination of the forces between the constituent atoms and ions. The size and structure of the crystal cell, for instance, is conditioned by the forces of attraction and repulsion. In certain simple polar crystals of the rocksalt type the forces of attraction may be regarded as known (being electrostatic), and so the forces of repulsion alone require investigation.

In some recent researches it has been shown that the forces between certain ions in crystals can be correlated with the forces between the inert gas atoms. The latter have been found by the methods of the kinetic theory, and thus the properties of a crystal have been co-ordinated with those of a gas.

Theoretical calculations have been made of the interatomic distances of a large number of crystals which are in satisfactory agreement with the observed values. The co-efficient of compressibility and electricity have also been calculated and found to be in fair agreement with the observed values (where these exist).

The information about ionic and atomic forces which has been obtained has been applied to other problems of crystal structure as yet unsolved. It has, for instance, thrown considerable light on the question as to why certain crystals such as CsCl set as body-centred cubics, while others such as NaCl set as face-centred cubics.

MEASUREMENTS ON THE THERMAL EXPANSION OF FUSED SILICA.

By WILMER SOUDER AND PETER HIDNERT.
(*U.S.A. Bureau of Standards.*)

ABSTRACT.

This paper gives the results of an investigation on the thermal expansion of transparent and non-transparent fused silica for various temperature ranges between −125 and +1,000° C. A total of 48 expansion tests were made on 17 samples of fused silica.

A detailed description of the apparatus and the methods used in this research and a summary of available data obtained by previous observers on the thermal expansion of fused silica are given.

A critical temperature or minimum length was found at about −80° C. Expansion occurred on heating fused silica above the critical temperature or cooling below this temperature. The coefficients of expansion of the transparent samples differ slightly from the coefficients of the non-transparent samples. Typical expansion curves are shown and discussed. The authors' average expansion curve is compared with the results of previous investigators. The table in the summary gives a résumé of average coefficients of expansion derived from the data on all samples for various temperature ranges between 20 and 1,000° C.

COMPARISON OF RESULTS.

The average expansion curve given in Figure 11 was derived from the data in the preceeding section. This curve may be considered to be the representative expansion curve of fused silica between −125 and

+1,000° C. Available data obtained from previous investigators are included in this figure for comparison.

The curve shows a minimum point at about −80° C. Expansion occurs on heating fused silica above −80° C., or cooling below this temperature. The lower portion of the expansion curve is concave upwards, and the upper portion is concave downwards.

The values of nearly all observers agree closely up to about 300° C. At higher temperatures greater variations may be seen. The results show the greatest scattering at 1,000° C. At high temperatures the values obtained by several observers are greater than the average results of the present research. Le Chatelier was not certain that his sample of fused silica was entirely amorphous, and Randall states that a source of error possibly existed in his results due to the titling of the interference system arising from unequal expansions in its supports.

Kaye states that it is probable that want of annealing is the cause in most of the anomalous results which have been obtained by some observers, and that this view is supported by the experiments of the National Physical Laboratory of England on the behaviour of specimens subject to a first heating as constrasted with their behaviour on subsequent heatings. The work done in the present research confirms the experiments of the National Physical Laboratory.

Sosman presents a hypothesis which he states would explain the variation in expansion between different samples. This hypothesis supposes the silica atomtriplets (SiO_2) to be joined up into threads.

These threads form in the liquid state, and their formation may begin even in the vapour. In the liquid they are in a constant state of vibration and movement, with the oxygen pairs in haphazard and probably varying orientation relative to the thread. A drop of silica glass in the neighbourhood of 1,700 to 1,800° would resemble a mass of wriggling worms. The threads themselves not improbably have a helical twist.

If the temperature is rapidly lowered, the threads become less and less active, until at last the mass becomes like a compressed pad of wires, and we have "solid" silica glass. An intricately tangled mass of wires has some of the properties of a solid, even though the individual wires are flexible.

The drawing out of a lump of such glass into a rod might naturally be expected to disturb the haphazard orientation parallel to the rod. This would explain the difference in expansion parallel and perpendicular to the axis in silica rods or tubes, and the variation in expansion between different samples, indicated by some experiments. It perhaps will also aid in explaining the evidences of ribbonlike crystallinity in silica glass rods, observed by Rayleigh. The thread hypothesis is also in accord with the familiar habit of amorphous silica of condensing in fine, fluffy, or lint-like forms. It has even been obtained from the electric furnace in microscopically fibrous massive form, a fibrous glass, which is wholly non-crystalline to an X-ray exposure of ordinary length, though showing traces of a structure under longer exposures.

Sosman states that his theory gives a satisfactory explanation for many phenomena of silica, such as the minimum in the temperature-volume curve of silica glass, but he does not discuss this phenomenon.

SUMMARY.

This paper gives the results of an investigation on the thermal expansion of transparent and non-transparent samples of fused silica over various temperature ranges between −125 and +1,000° C. Seventeen samples of fused silica were studied. A total of 48 expansion tests were made on these specimens.

A detailed description of the apparatus and the methods used in this research and a summary of available data obtained by previous observers on the thermal expansion of fused silica are given.

A critical temperature or minimum length was found at about −80° C. Expansion occurred on heating fused silica above the critical temperature or cooling below this temperature. The coefficients of expansion are therefore positive above the critical temperature and negative below this temperature. The coefficients of expansion of the transparent samples differ slightly from the coefficients of the non-transparent samples.

In nearly every case the samples indicated a very small increase in length after heating to 1,000°C. and cooling to room temperature.

Typical expansion curves are shown and discussed.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

The following papers were read at the meeting held on March 25, 1926 :—

The Secretion of Pituitrin in Mammals, as Shown by Perfusion of the Isolated Kidney of the Dog. By E. B. VERNEY. Communicated by Prof. T. R. Elliott, F.R.S.

The isolated kidney of the dog has been used as a means whereby the blood supplying it may be tested as to its content in pituitrin-like substance.

When the head and neck of a dog are switched into perfusion-parallel with the isolated kidney, the blood picks up during its passage through the head and neck a substance or substances which inhibit the polyuria of the isolated kidney, augment the urinary chloride output percentually, or sometimes absolutely, and diminish the renal blood flow.

This result is still obtained after previous exposure of the pituitary body.

No such phenomenon occurs as the result of perfusing the pelvis and lower limbs of a dog in parallel with the kidney.

Previous removal of the pituitary body abolishes the reaction summarised in 2 above.

An antidiuretic, chloride-augmenting, and vaso-coustrictor principle or principles are contributed by the pituitary body to blood during its passage through the head of a dog.

On the Geometry of Dynamics. By J. L. SYNGE. Communicated by Prof. A. W. Conway, F.R.S.

Although representation of configurations by points of multi-dimensional Riemannian space has been used to discuss certain aspects of classical dynamical theory, the present paper is believed to be the first development along these lines with a claim to comprehensiveness. Tensor notation is used throughout, and to the advantages of this notation, in compactness and suggestion novel results are due. It is an instrument that may prove as essential to workers in classical dynamics as it has to the relativist.

The paper contains parallel discussions corresponding to two line-elements — the "kinematical" line-element, $ds^2 = 2Tdt^2 = a_{mn} dq^m dq^n$, and the "action" line-element, $ds^2 = 2(h - V) Tdt^2 = (h - V) a_{mn} dq^m dq$, the importance of both of which was recognised long ago. After a preliminary résumé of some geometrical theorems, the laws of motion are discussed, leading to a generalisation of Bonnet's theorem on particle orbits and a geometrical elucidation of the Principle of Least Curvature.

A completely determinate form of the Langragangian equations for non-holonomic systems is developed. Necessary and sufficient conditions are obtained for the admissibility of $(N - 1)$ ignorable co-ordinates in a system with N degrees of freedom.

The paper next deals with the general question of stability. From an invariant geometrical definition of stability three special types of particular dynamical importance are selected for discussion. A new definition of steady motion is given. The system of normals to a curve, originally defined by Blaschke, plays a fundamental part. The method employed avoids the artificial restriction to disturbances which do not change the ignorable momenta—a restriction which limits the physical interest of the method of total energy.

The Absorption-Spectra of Some Naphthalene Derivatives in Vapour and Solution. By H. G. DE LASZLO. Communicated by Sir Ernest Rutherford, Pres.R.S.

The ultra-violet absorption spectra of the following monoderivatives of naphthalene containing the groups CH_3, Cl, Br, OH, COOH, CN, and NH_2, were measured in vapour and in hexane solution. A marked difference was found between the spectra of the α and β isomers, the β spectra being more like that of naphthalene than the α spectra. All these spectra were more or less shifted towards the red when compared with naphthalene. The amount of this shift is of the same order in the case of naphthalene and benzene derivatives containing the same group, except that it is always a little greater in the latter case. The various groups have a similar action on the spectra of both naphthalene and benzene.

The solution spectra are always shifted towards the red when compared with the vapour. This shift varies with the group which suggests that a modified "Stark effect" is taking place on the absorption bands when the dipolar molecules are in the strong electric field of the solvent. The

following derivatives possess a fine structure in a state of vapour β-CH_3, $\alpha + \beta$-OH, β-NH_2, β-Br, β-Cl, indicating a fairly rigid structure, *while* α-*Br*, $\alpha + \beta$-CN, *and* α-CH_3 have only one sharp band edge.

The bands of most of the bodies examined have been ranged in simple series. These periodicities, representing the atomic oscillations, are all smaller than that of the parent body *and appear again in the infrared.*

GEOLOGICAL SOCIETY OF LONDON.

June 23, 1926.

Prof. Henry Fairfield Osborn, For.Memb. G.S., delivered a lecture on the *Methods and Results of the American Museum Expedition in the Gobi Desert*, 1922-1925.

He said that a new volume in the life-history of the Earth, composed up to the present of 24 chapters, had been revealed by the discoveries of the Mongolian Expeditions of the American Museum of Natural History, under the leadership of Roy Chapman Andrews. Central Asia, and especially the region east and south-east of Chinese Turkestan, had long remained the *terra incognita* of geology, palæontology, and, in a minor sense, of geography. In 1900 the lecturer predicted that the unknown high-plateau region of Central Asia, rather than the well-known Asiatic provinces on the south, such as the Siwalik Hills of India, explored by Hugh Falconer (1830-1850), would prove to be the chief centre of the origin and distribution of the mamalia from which waves of north mammalian life radiated to the continents of Europe and of North America.

Andrew's expeditions in the three seasons of 1922, 1923, and 1925, have not only completely verified this prediction, but have also revealed the high Central Asiatic plateau region as the chief home of the terrestrial deinosaurian reptiles of Upper Jurassic and of Cretaceous time. In brief, these discoveries establish Mongolia as a chief centre of northern terrestrial life-history, from the close of urassis time onwards to the very close of Pleistocene time.

From the standpoint of palæogeography the outstanding geological discoveries of the expedition are:—

First, that this Central Asiatic continent of Gobia, as it has been named by Grabau, was for several millions of years extremely favourable to the evolution of reptiles, mammals, insects, and plants, and probably birds as well, hitherto known along the low-lying Cretaceous forelands of Western Europe (such as the Wealden of England and Belgium), and in less degree of Southern Asia. Secondly, that this now terribly desert region of Gobia, traversed only by the gazelle and the wild ass, and thoroughly uninhabitable in the summer season, was abounding in life throughout Upper urassic, and throughout all Cretaceous and Tertiary time, sparsely forested, traversed by streams and rivers, with a limited seasonal rain-supply like the high plateau region of Central Africa to-day. Thirdly, these dry and stimulating upland conditions of Tertiary time, as compared with the densely forested conditions of the Asiatic lowlands, have led to the recent prediction by the lecturer on returning from Iren Dabasu in 1923, that this region is the most likely one in which to search for the Tertiary ancestors of man, namely, those of Eolithic or Dawn-stone Age, though no traces of man have, as yet, been discovered hy the expedition older than those of Lower Palæolithic age. The discovery of human and pre-human remains in Tertiary time has thus become one of the chief remaining objects of the expedition.

During the season of 1925 a great culture-camp, probably of Azilian-Campignian time, was discovered on the eastern slopes of the Altai Range, not far from Shabarakh, and not far from Djadokhta, where the now famous deinosaur eggs were discovered, far north of the Ordos locality explored by Licent and Teilhard de Chardin. In fact, these Upper Palæolithic artizans collected the broken shells of the deinosaur eggs with which to manufacture necklace ornaments, these perforated fossil shells serving as well as the recent eggshells of the giant *Struthiolithus*, the great ostrich of the Stone Age of Mongolia. No human fossils have so far been found; the industrial levels are not as yet precisely determinable, but the chief anthropological fact is established that the Stone Age tribes spread over the borders of the Gobi Desert region during the Ice Age, establishing their quarries near the large lakes bordering the Altai Mountains on the east and ged by glacial streams. The geologists of the party have discovered traces of this glacial age along the summits of the Altai Range.

As for methods, by combining a very large caravan for the camel transport, which leaves Kalgan on the 1st of December, and reaches the eastern base of the Altai Range on the 1st of May, with an automobile train of five to seven cars, the expedition had the great advantage of speed over the previous geological explorers who crossed the Desert with camels only. The geologists and palæontologists of the party, Granger, Berkey, and Morris, with two field assistants, also had the advantage of prolonged experience in the field formations of the Western United States, which, between the 50th and 40th parallels of latitude, present conditions remarkably similar to those found in the Desert of Gobi. Raphael Pumpelly in 1864, Ferdinand von Richthofen in 1872, and V. A. Obruchev in 1909, found no fossils, except the single rhinoceros-tooth brought back by Obruchev; and other geologists traversing this region have thought that there were no fossils to be found.

As to geology, the expeditions beginning on April 15, 1922, 260 miles north-west of Kalgan, and encircling in 1922, 1923, and 1925, the entire Gobi district in a 3,000-mile radius, discovered no fewer than 23 distinct geological formations extending downwards from Lower Pleistocene time into Lower Cretaceous and Upper Jurassic. These have a thickness varying from 50 to 3,000 feet, and were deposited either in the great flood-plains of ancient rivers, or in broad river-valleys, or at the base of ancient mountain-chains, or in the torrents of great sandstorms such as the Djodokhta, testifying to the secular vicissitudes of climate, mostly of rainfall, terminating with the pluvial period of the Ice Age, followed by a long period of secular desiccation.

Some of these formations prove to be closely contemporaneous with the Lower Cretaceous Wealden of Western Europe, owing to the presence of large Iguanodonts, equalling the famous *I. bernissartiensis* of of Belgium in size. The oldest are as early as the Oxfordian and Purbeck of Upper Jurassic times. The climax of reptilian life is reached in the marvellous sand-swept deinosaur breeding-grounds of Middle Cretaceous time, where nests of fossil eggs and innumerable skulls and skeletons of *Protoceratops* are found in almost perfect preservation. This is the richest deinosaur deposit thus far discovered in Eurasia.

As to the 15 succeeding Tertiary formations, they compose so many unbroken chapters of the history of Mongolian life as extend from the basal Eocene Gashato to Upper Oligocene time, where the giant *Baluchitherium* occurs, as discovered also in Baluchistan by Cooper of Cambridge, and in Chinese Turkestan by Borrissiak of Moscow. The Miocene and the Pliocene Periods are represented by four formations.

Thus the scientific staff of the Expedition, between the years 1922 and 1925, has interpreted one of the most typically desert regions of the entire world by means of the twin sciences of palæontology and geology, and the wilderness of Mongolia now blossoms forth with its glorious story of prehistoric life, as the homeland of the greater number of known upland terrestrial vertebrates.

ROYAL SOCIETY OF ARTS.

Presentation of the Society's Albert Medal to Professor Paul Sabatier.

The Council of the Royal Society of Arts attended at Clarence House on July 22, when H.R.H. the Duke of Connaught, K.G., President of the Society, presented the Society's Albert Medal for 1926 to Professor Paul Sabatier, Member of the Institute of France, Foreign Member of the Royal Society, Davy Medallist, Nobel Prizeman, "in recognition of his distinguished work in science and of the eminent services to industry rendered by his renowned researches in physics and chemistry, which laid the foundation of important industrial processes."

SWEDISH TELEPHONES AND TELEGRAPHS.

The British Commercial Secretary at Stockholm reports that, according to the annual report of the Swedish Telegraph Administration, the number of telephone apparatus in use throughout the country in 1925 was approximately 434,594, or about 72 telephone instruments to every 1,000 inhabitants (Stockholm 282 per 1,000 inhabitants). The total number of conversations recorded in 1925 was 640,318,200, an increase of 5 per cent. over 1924. Subscribers to the State telephone system also increased from 338,187 in 1924 to 352,722 last year. The Telegraph Administration employees numbered 15,041 (including 9,800 women), an increase of 218 as compared with 1924. At the end of last year there were 4,593 telephone stations in Sweden, as compared with 4,477 at the end of the previous year, while the total length of the State telephone

conductors was 817,162 kilometres; telegraph lines totalled 44,850 kilometres (excluding railways). At the end of 1925 there were 3,604 telegraph stations in Sweden, as against 3,566 in 1924, while the number of wireless telegraph installations on board ships in 1925 totalled 296. Telegrams handled last year numbered 17,193,931, against 16,580,444 in 1924.

The gross receipts of the Telegraph Administration in 1925 amounted to 81,685,168 kronor, as against 80,110,125 kr. in 1924, and was made up as follows: Telephones, 69,397,629 kr.; telegraphs, 7,938,486 kr.; rents, 2,315,350 kr.; and wireless, 2,033,703 kr.

TABLE OF ATOMIC WEIGHTS.

Anent the Table of Japanese Atomic Weights, published on p. 45, July 16 issue, and the footnote appended thereto, we have to point out that the well-known firm of F. E. Becker (Proprietors, W. & J. George, (London), Ltd.), of 17 to 29, Hatton Wall, London, E.C.1., publish an authentic Table of Atomic Weights (as issued by the International Union of Pure and Applied Chemistry, 1925, reprinted from *Chemistry and Industry*, Vol. 44, No. 6., February 6, 1925. A copy of this table will be sent by Messrs. Becker free of charge to any reader of the *Chemical News* who may desire same.

NOTICES OF BOOKS.

International Critical Tables of Numerical Data: Physics, Chemistry, and Technology. Vol. I.

This ambitious work, which extends to some 430 large 4to pages, has been prepared under the auspices of the International Research Council and the National Academy of Sciences by the National Research Council of the United States of America. In connection with its production there has been in existence a Board of Trustees and a Board of Editors, and a great part of the work is printed in four languages. It is published by the McGraw-Hill Book Company, Inc., of 370, Seventh Street, New York, and 6 & 8, Bouverie Street, London. Price 12 dollars.

There is published a list of some hundreds of prominent firms whose co-operation to the tune of 170,000 dollars rendered it possible to complete the work and issue it at the published price, while suggestions, advice and help were given by corresponding editors and advisory committees in various countries.

The Preface and Introduction are given in English, French, German and Italian, and it would be difficult surely to find any votary of science who would not be able to read one or other of these languages.

The idea of the issue of these Tables was approved by the organisation meeting in London in 1919 of the International Union of Pure and Applied Chemistry. The National Research Council of the United States, on behalf of the National Academy of Sciences, accepted the responsibility of the project. The preliminary arrangement was in itself a big task, as on it depended very largely the success of the undertaking.

We learn that in the general plan, the subject matter was divided into some 300 different sections, after which the corresponding editors were asked to recommend one or more persons for the several sections who should possess special knowledge of the subject. We further learn that in the course of its labours the Board of Editors has enjoyed the co operation of numerous organisations and individuals whose advice, suggestions and assistance, in many ways have greatly aided it in its complex and difficult task. It says that it is especially indebted to the several corresponding editors and their advisory committees, who have generously contributed their time and thought to the success of the work; to the special editors; to the U.S.A. Bnreau of Standards; the National Physical Laboratory of Great Britain; and the Physical Society of France; to the International Commission in charge of the Annual Tables; and to various organisations and individuals who made available unpublished data for the use of the co-operating experts.

In preparing the various sections, the co-operating experts were instructed (1) To include in the Bibliography (a) only the sources of the data upon which their reported values actually rest, and (b) the sources of available data of the same kind pertaining to those systems for which no numerical value is given. Hence it is not intended to be a complete bibliography of the field. (2) To omit from the tables of

numerical data all those systems for which the available data (a) were of slight scientific or practical interest, or (b) were so discordant as to be of little, if any, value. (3) To set forth the results of their work in the form of text, equations, tables, graphs, or charts, as seeemed most appropriate under the circumstances, having regard to space economy. (4) To give only selected samples illustrating types in the case of very large and heterogeneous fields, such as colloids, chemical kinetics, and certain classes of Industrial materials. (5) To restrict the accompanying explanations and text to the amount necessary for the intelligent use of the data. (Under this restriction, the expert is given no opportunity to present a general discussion of his subject or of the methods by which he obtained the value given.)

From the foregoing it will be obvious that anything in the nature of padding or nonessentials have been excluded. There are given at the onset national and local systems of weights and measures, which occupy some dozens of pages, from which it is obvious that the list is pretty complete. Then follow in alphabetical order a selected list of technical terms, Atomic, Elements and Atoms, including divers illustrations, are then given; Thermometry, Temperatures and Temperature Differences for every 100 microvolts; Laboratory methods for producing and maintaining constant Temperature and Humidity; Standard Buffer Solutions and Acid-liase Indicators; Psychological Data Pertaining to Errors of Observation; Elementary Substances and Atmospheric Air, bring us up to Page 103. Chemical Compounds with the Formulæ; Molecular Weight; Normal Melting Point °C.; Specific Gravity, etc., in each case, carry us on to page 274. A Refractive Index and an Alphabetical Index to I Table occupy a number of pages. Property Substance Tables, Crystallography, X-Ray Refraction Data; Some Numerical Data Pertaining to Dispersoidology (illustrated); Sweetening Agents and Odoriferous Materials are followed by chapters on Radioactive Elements and their Constants, and selected Physical Properties of Stars and Nebulæ; Geodetic Data, and Aerodynamics.

From the incomplete enumeration of the contents, it will be seen that the volume is one of the most important scientific books that has been published in recent years.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

18,027.—Binz, A.—Production of organic arseno compounds. July 22nd.

18,247.—Denmann, W. — Neutralizing ammonia crystals. July 21st.

18,263.—Leon, C. van.—Preparation of alcoholates. July 21st.

18,143.—Mathieson Alkali Works.—Production of chromium compounds. July 20th.

Specifications Published.

255,127.—Badische Anilin & Soda Fabrik.—Manufacture and production of organic compounds.

255,144.—Koppers Co.—Removal of hydrogen sulphide and other noxious constituents from gases.

255,167.—Richardson, G.—Manufacture of barium sulphide.

255,346.—I. G. Farbenindustrie Akt-Ges.—Process for obtaining perfumes from flowers and other parts of plants.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

STRANGLEBRAND.

459,816.—Chemical Washes for agricultural & horticultural purposes.—London Fertiliser Co., Ltd., 30, King William Street, London, E.C.4. July 28th.

SAPALCOL.

465,423.—Chemical substances prepared for use in medicine and pharmacy.—Sapalcol Aktiengesellschaft fur Pharmazeutische U. Kosmetische Praparate, 31, Vorgebirgstrasse, Koln-Ehrenfeld, Germany. July July 28th.

UNIVERSITY OF MANCHESTER.

CHEMISTRY COURSES.

A Prospectus containing full particulars of the Lectures and Laboratory Courses qualifying for Degrees in Chemistry will be forwarded on application to the Registrar.

The Session commences on October 7th. Applications for admission to the Research Laboratories should be made to the Director of the Chemical Laboratories.

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Handsome Red Cloth (stiff) Binding Cases, Gold-lettered, for Binding the *Chemical News*, can now be had from the Office, Merton House, Salisbury Square, London, E.C.4. Price 3/-; post free, 3/3; or two Cases in one parcel, post free 6/-.

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Readers requiring information and advice respecting Patents and Trade Marks will receive the same free from Rayner & Co., Patent Agents, 5, Chancery Lane, London, W.C.2.

FULL-TIME TEACHERS Required in the PHYSICS and the CHEMISTRY Departments of the Northern Polytechnic. Good Degree essential. Salary, Burnham scale according to qualifications and experience. Applications to be received by the 6th September. Forms to be obtained from the Clerk to the Governors, Northern Polytechnic, Holloway, London, E.7.

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INDEX DOUBLE NUMBER NEXT WEEK.

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COMMERCIALISATION OF THE HORMONES.

By JOHN MISSENDEN, B.Sc.

This is a subject which has come into considerable prominence these last few months, especially during the discussion which was held at the recent meeting of the Society of Chemical Industry and the Bio-Chemical Society. A number of important papers were read which dealt solely with the hormones, and much light was thrown not only upon the history of these substances, but also upon their future possibilities.

It is indeed wonderful to reflect upon the incalculable value of the hormones in medicine; but it is still more wonderful to appreciate the immense difficulties which have had to be oevrcome in isolating them. This does not apply so much to adrenalin as it does to those two more mysterious compounds, thyroxin and insulin; yet in all three, the chemist has captured the active principle of three ductless glands, and I would dare the suggestion—and perhaps be hopelessly at fault in so doing—that he will one day capture a fourth : the hormone (if one exists) which will stay the ravages of cancer. One cannot help feeling that this is a not too unreasonable expectation, and that the course of this disease will be checked in just the same manner as insulin has checked *diabetes mellitus.* The fact that the removal of the pancreas (the source of insulin) brings about a diabetic condition is well known.

To return now to the existing isolated hormones, the chief difficulty about their use is their cost. This is an aspect which has presented itself very urgently to modern research, and Drs. Dale and Dudley, with their colleague, Mr. F. H. Carr, have at last contributed valuable theses upon our knowledge of future prospects in this direction.

As Mr. Carr explained in his paper, the great problem in extracting the hormones, thyroxin and insulin from the glands in which they are contained, is time. It is a quite easy matter for these hormones to lose much of their activity before they can be isolated, or, again, they may be rendered practically useless from contamination by decomposition products. This is because no sooner has cessation of life occured than certain chemical changes are bound to take place within the tissues. This I explained partly in my article, "Testing for Death," which appeared in the April issue of *Modern Science.*

It seems that in the case of insulin, the whole of it can be completely destroyed by these changes within a few hours of death. Obviously, then, any process which aims at its isolation on a reasonably large scale must take this fact into account.

THE ISOLATION OF INSULIN.

It has been found that this deterioration may be very much retarded if, as soon as death is certain, the gland be removed from the carcase and reduced as speedily as possible to a temperature of 1° C., or less, and a great deal of attention has been given to the ways and means whereby this can be done. It is necessary, first of all, to remove from the excised pancreas as much as possible of the superfluous tissue, and Mr. Carr

laid particular stress upon clearing away certain portions of the gut, so that the enterokinase which is contained in it might not excite the pancreatic enzymes into harmful activity.

The next step is freezing, which occupied some little time in description. This is done in a well-ventilated chamber in which the air inlets are controlled by a part of the freezing apparatus. The glands are laid out in sinble layers in this chamber, which is at a temperature of - 5° C., or less, and is kept so by a calcium chloride solution cascade passing over the ammonia coils and then given intimate contact with the incoming air. This ingenious arrangement has an extremely quick chilling effect, while the cost of materials is not high, the whole plant being operated on a circulatory basis.

Even freezing, however, does not entirely stop the post-mortem decompository tendencies of the gland tissue, and speed is still an essential factor. That is why it was recommended that, rather than make subsequent operations a " batch " process, it is far more desirable—and perhaps more economical—to adopt a continuous one. Here another consideration arises once the freezng temperature is abandoned : decomposition is likely to proceed at a far greater pace than before. Therefore, expedition is doubly vital.

Advantage must be taken, then, of the latent heat of liquefaction. At the commencement of the process of extraction, the temperature of the gland is - 5° C., assuming that this is the selected temperature of the freezing chamber. The first stage of extraction consists in grinding the frozen gland, continuously incorpprating alcohol and acid as the division proceeds, and afterwards continuously filtering and evaporating.

Remembering the advantage that must be taken of the latent heat of liquefaction, it is found that the grinding itself, in spite of its temperature-raising tendencies, does not bring the gland past 0° C., until the acid has penetrated sufficiently to stop loss of hormone-activity. This is an achievement indeed, because it makes the percentage of the extract far higher than would otherwise be the case.

In practice, the grinding is done in two distinct stages. Firstly, the gland at -5° C. is coarsely ground so as to render its acidulation complete; then it is finely ground, an operation than can be carried out in complete safely now that the acid has done its work. The resultant material is a mixture of pulverised pancreas, alcohol, and acid; there being 65% of alcohol present, the whole showing a PH reading of 3.5.

Even now, however, a low temperature is essential, for decompository actions are still possible, a fact which is explained with emphasis. " The amount of destruction of insulin taking place during any part of the process until all enzymic and bacterial actions have been eliminated is a function of the factor—temperature multiplied by time." This applies particularly to that part of the process which entails concentration. Hence a method has been devised whereby the progress of evaporation is considerably accelerated by vacuum pumps, the subsequent condensation being done in tubes, the outside of which are cooled by brine at zero.

Now we come to the actual purification of insulin itself. Isolation is effected fractionally by a series of protein precipitants. One peculiarity of insulin is that, while it is not soluble in water at an acidity of PH 5.0, it *is* soluble at this acidity when in association with other proteins. The following-through of the final purigcation stages is a highly technical process that has been perfected by Dr. Dudley, and entails a careful observance of PH values during the throwing down of the various fractions. The task is no easy one, and the least divergence from the carefully planned method reduces the activity of the insulin obtainable.

THYROXIN.

Dr. Harrington's work in connection with this hormone shows a somewhat startling result. Thyroxin is, of course, the active principle of the thyroid gland, and it has had much prominence lately under the pseudonym of " monkey-gland treatment." With the idea that this substance owes its pronounced effects upon human metabolism to the fact that it originates in monkeys—as, indeed, it can do—I am not concerned; nevertheless it is interesting to note the popular connection between monkeys and the increased friskiness of human beings who have had the thyroid treatment!

Recent research shows that the old method of hydrolysis with caustic soda is bad, because it makes for a small yield. Hydrolysis is, of course, an absolutely

essential part of the process for isolating thyroxin from the gland, and Mr. Carr advanced the most interesting suggestion that perhaps this is because the hormone is a disintegration product of some other chemical substance. This is, of course, purely an assumption arising from the necessity for hydrolysis, and not a conclusion arrived at by experiment.

Dr. Harrington thought, at the outset of his investigation, that the production with caustic soda was far too low, and accounted for it by advancing the theory that the process was somewhat drastic, much of the thyroxin being destroyed in consequence. He tried hydrolysis with barytes, therefore, and the result was a yield *twenty-five times as great.*

The process is a fairly simple one, and very speedy. The dried thyroid gland is hydrolysed for six hours with baryta water, separated, and treated further with 5% caustic soda for a quarter of an hour. The two liquors thus obtained are acidified, a precipitate being thrown down. This is boiled for eighteen hours with strong baryta, and leaves an insoluble substance which is found to be the barium compound of thyroxin. The details to be observed in the preparation of the thyroid gland are the same as those described for the pancreas.

The Old Adrenalin.

This hormone, as explained by Dr. H. A. D. Jowett, is the only one whose chemical constitution has been definitely established. It is not by any means a recent discovery, or even a recently commercialised product; but it deserves its place in this article because it was the first of the hormones to be discovered, and, like thyroxin, it can be produced as a *tangible* chemical substance, capable of being weighed and otherwise measured to a most exact degree. Both of these hormones have a crystalline structure.

After numerous experiments upon the finding of an extract—these took place in 1895-1901 — the observed physiological results were unsatisfactory, and it was left to Takamine in the latter year to separate once and for all this most powerful of hæmostatic agents. There followed a long —and, at times, violent—controversy upon its exact chemical constitution, but the work of real value had been done, and the first of the hormones was ready for study in its pharmacological application. The following of two more is indicative of equally brilliant research, and the report of the work which has been done to place them

HALL EFFECT IN EVAPORATED FILMS OF IRON, COBALT, NICKEL PALLADIUM, AND PLATINUM.

By H. B. Peacock.

(*Extracted from the "Physical Review."*)

Hall Coefficients of Evaporated Films. The Hall coefficients for films of Fe, Co, Ni, Pd, and Pt, 6 to 270$\mu\mu$ thick, deposited on surfaces at a distance less than the mean free path from the evaporating filament, were respectively 1.4, 4.9, and 7.8 times the values for the corresponding metals in bulk, these factors being in the order of the atomic numbers of the elements. For the paramagnetic, negative Hall effect metals, Pd and Pt, the Hall coefficients were 0.66 and 0.64 times the values for the metals in bulk. The increased Hall effect for the films of the ferromagnetic metals seems closely related to ferromagnetism, although Ni, the least ferromagnetic of the three, shows the greatest variation. Films of Ir and Rh formed at a distance less than the mean free path from the evaporating filament, showed for Ir a positive Hall effect as in bulk, and for Rh no detectable effect.

Specific Resistance of Evaporated Films. —The ratios of the specific resistances of the evaporated films to the specific resistances of the corresponding metals in bulk were found to be 3.1 (Fe), 28.0 (Co), 25.0 (Ni), 4.4 (Pd), 14.0 (Pt), 10.8 (Ir), 12.0 (Rh).

Saturation of the Hall e.m.f.—Curves show that the saturation of the Hall e.m.f. occurs for evaporated Fe at a slightly lower magnetic induction than for Fe in bulk; for Co, at about 12,500 gauss as compared with 18.500 for bulk; and for Ni, at about 2500-3000 as compared with 6000 for bulk. It is significant that the magnitudes of these variations from bulk values, like the corresponding variations in the Hall coefficient, occur in the order of these elements in the periodic table.

Effects of Heating.—Heating films of the ferromagnetic metals during or after deposition decreased the Hall coefficients and specific resistances to approximately the values for the metals in bulk. It also caused a shift in the value of the magnetic induction necessary to produce saturation of the Hall e.m.f. toward that for the metals in bulk. No effect of heating was observed in the paramagnetic metals.

Interpretation.—Evaporated films may differ from bulk metal in the size of the crystalline grains, in the nature of the material between them or in an asymmetry

British Association for the Advancement of Science.

SECTION B—CHEMISTRY.

THE SCOPE OF ORGANIC CHEMISTRY.

ADDRESS BY PROFESSOR J. F. THORPE, C.B.E., D.Sc., Ph.D., F.R.S.
PRESIDENT OF THE SECTION.

(*Continued from Last Week.*)

PETROLEUM.

"The complex hydrocarbons which form the main constituents of crude petroleum belong to a section of organic chemistry at present too little explored. Although many millions have been made through the production and sale of petroleum products, it is safe to say that the percentage of profit devoted to research in oil products has been infinitesimal. It is true that in the United States large sums are given by the oil interests towards research in other subjects, but until quite recently none of these was, curiously enough, given for the purpose of improving our knowledge of the science on which the utilisation and isolation of petroleum products depends. The reason is not far to seek. The apparently inexhaustible supplies of petroleum renders is unnecessary to devise means for economical working. The crudest and most wasteful methods were employed, because economy and the conservation of the natural product were not paying propositions. This applies not only to the methods used in fractionisation, but to those employed for the purpose of 'cracking' the higher boiling fractions into liquids of lower boiling point. For at the present moment it is the fraction up to 200° C. which is the important product, because it is the 'petrol' of the internal combustion engine. Time was, before the introduction of this particular machine, when the light fraction from crude petroleum was a drug on the market, and in many cases was actually set on fire at the refinery because no use could be found for it. In those days the chief product was the kerosene fraction which was used as lamp oil. At the present time the rapid increase in the use of the motor car for personal and commercial transport indicates that at no distant period, if progress continues to be made in the same direction, the amount of the 'petrol' fraction will be insufficient for the world's needs. This point has already been reached in America, where approximately 70 per cent. of the world's consumption of petrol (gasoline) is effected. During 1925 the consumption of petrol in the U.S.A. approached 800,000,000 gallons a month, which is about twelve times the amount consumed in this country. It has been stated that one in every five persons in the States—men, women and children—possess a motor car*, and ,be this as it may, it is evident that to meet such a colossal consumption means have to be found to utilise the higher boiling fractions, and indeed even the residues from the distillation processes. This 'cracking' operation is now carried out on an enormous scale by numerous processes, all subject to patents, but differing from one another but slightly on the question of principle. All depend on the well-established fact that hydrocarbons of high molecular weight will break down into those of lower molecular weight if they are subjected to the requisite degree of temperature. Pressure appears to play an important part in the character of the product, as does also the surface action of the container or material used in the container to promote surface action. All are wasteful, because little or no research has been carried out on the true chemical nature of the cracking operation. Much permanent gas is always produced, consisting for the most part of ethylene and propylene. In the States the ethylene is allowed to go free, because its obvious utilisation in the form of ethyl alcohol is attended with difficulties, but the propylene is usually absorbed in sulphuric acid, and thus converted into *iso*-propyl alcohol, useful as a solvent. The

*Cars registered on January 1, 1925, were: U.S.A., 17,591,981; Canada, 688,794; Great Britain, 1,094,534.

production of these two unsaturated hydrocarbons provides a clue to the mechanism of the cracking process which is of some significance. If you break a long chain-saturated hydrocargon one of your products must be an unsaturated hydrocarbon, and it is evident that cracked spirit contains a considerable proportion of such unsaturated bodies. Moreover, the cracking processes at present in use do not produce aromatic hydrocarbons, and it is on the presence of a proportion of these aromatic hydrocarbons that certain special properties of petrol depend. For example, the tendency at the present time is to produce for motor cars internal combustion engines of increased compression ratio, in order mainly to diminish the petrol consumption and thus increase mileage per gallon consumed. For some reason, which research has not yet ascertained, the use of petrol which does not contain the right quantity of aromatic hydrocarhons of the benzene type leads to 'detonation,' 'knocking,' or 'pinking' when ignited in cylinders giving more than a small compression ratio. This detriment diminishes the value of cracked spirit as such for any by low-compression engines, and many have been the devices suggested in order to overcome this difficulty. A vast number of substances, selected more or less at random, have been tried as 'anti-knock' materials, and as an outcome it has been found that one, namely, lead tetraethyl possesses the property, when present in exceedingly small quantities, of preventing the 'detonation' of the explosion mixture in the cylinder. For a time lead tetraethyl (ethyl gas) fell under a ban in the States owing to a fatal accident which attended the spilling of a certain amount in one of the American factories, but it is understood that further investigation has led to a revision of the view first formed, and that considerable quantities of 'ethyl gas' are now being used. The writer remembers visiting Wilmington in 1924, when some 500 gallons of lead tetraethyl were being made daily. Although there was naturally a strong smell of the material in the factory building, and he remained for some hours there, no ill-effects were noticed. It is obvious that the conditions which produce 'knocking,' and the reason why certain substances are 'anti-knock' compounds, and why the presence of aromatic hydrocarbons prevent the phenomenon, must be made the subject of systematic research.

The question is also one of national importance, because in the case of high-compression engines, such as those used in aeroplanes, it is essential that a petrol should be used containing a high percentage of aromatic hydrocarbons. In war time these aromatic compounds will be required for the manufacture of explosives, and it is quite certain that there will not be enough for both purposes.

Nevertheless, it must be remembered that it is only at the moment that the low boiling fraction of petroleum is the chief marketable product. It is probable that progress in the future will tend more and more to produce a motor-car engine of the Diesel type, or one having a carburettor capable of effectively vapourising the higher fractions of petroleum. In these circumstances it may well be that the low fraction will become the less important part of crude petroleum, and that, instead of having to resort to 'cracking,' a process of synthesis, by which the lower hydrocarbons can be converted into higher ones, will have to be adopted. As a matter of fact there are methods known by which this can be effected. Pure *iso*amylene can. for example, be converted into diamylene by interaction with stannic or aluminium chloride, and the process can be carried further, so that perfectly good lubricating oils can now be made by the polymerisation of the lower unsaturated hydrocarbons.

Polymerisation and depolymerisation are, therefore, the two operatons which the petroleum industry must investigate and establish on a firm scientific basis by research, so that it may be in a position to supply the public need for any particular form of engine which the engineer may evolve. Especially is it desirable to ascertain under what conditions polymerisation leads to the formation of aromatic and napthenic hydrocarbons. Considerable attention has been drawn within recent times to what may be termed in general the Bergius processes for depolymerising organic substances. The operation, which consists in heating the material under high pressure in the presence of hydrogen, was introduced in the first instance for the treatment of coal. There can be no question that great and fundamental changes are brought about in organic substances by the treatment whether a catyst is present or not, and that a wide field for research is opened up thereby, but it is doubtfnl if, at

the moment, general operations of this type can be regarded as commercial propositions. The plant is exceeding costly and the conditions subject to wide variations which are difficult to control. Actually it has been ascertained that in the 'cracking' of the kerosene fraction of petroleum hydrogen is unnecessary, and can be replaced by nitrogen without affecting the character of the final product.

Little is known of the constituents of crude petroleum, or indeed fractions into which it can be separated after purification and distillation. Some of the simpler hydrocarbons of the pentane and hexane type have been isolated and the presence of cyclic compounds has been established. Many of them are classed under the head of 'naphthenes,' but these are of uncertain structure. No doubt many are present in the crude oil, but it is certain that others are formed during the distillation process. It is clear that much opportunity for research work offers itself here, and it is probable that small alterations in the method of distilation may cause deep-seated changes in the character of the distillate, causing it to be of greater service for particular purposes. The occurrence of hydrocarbons of the naphthalene series in petroleum products has also been clearly established. The higher fractions which constitute the valuable lubricating oils also need attention, for it is now certain that *viscosity bears no relation to oiliness, that* is, the capacity for acting as an efficient lubricator. The addition of smal quantities of 'polar' substances of the type of fatty oils or acids confers increased oiliness on these compounds, and although we are now gradually reaching a stage when we know more about the effects of such ingredients, the field for research is still a large and important one.

The formation of free carbon occurs during both the distillation and 'cracking' process, in some cases to a very considerable extent. The utilisation of this carbon for the purposes of making electrodes is an important part of the industry, and the formation of carbon in a condition in which it can be used by the rubber tyre manufacturers is also likely to become practicable as an outcome of the *thermal decomposition* of hydrocarbons.

At present we know nothing about the structure of the hydrocarbons present in the lubricating oils. Indeed, it seems possible that these may not be long-chain hydrocarbon with which the organic chemist is familiar, but rather polymerised products formed from unsaturated components liable to be formed or destroyed under comparatively mild conditions. The relative ease with which the oil in the engine sump of a motor car loses its oiliness through continued use is not characteristic of the stability usually associated with an organic hydrocarbon. Recent researches on the formation of dimeric products of the simple type

$$\begin{array}{l} XCH=CHY \\ XCH=CHY \end{array} \rightarrow \begin{array}{c} XCH-CHY \\ | \quad\quad | \\ XCH-CHY \end{array} \text{ or } \begin{array}{c} XCH-CHY \\ | \quad\quad | \\ YCH-CHX \end{array}$$

shows that the ease of formation and stability of such systems depend on the composition of X and Y. In some cases stable complexes of this kind are formed which can be distilled without undergoing disruption, but which are broken down slowly on prolonged heating even at a moderate temperature.

In the complex hydrocarbons under discussion the letters X and Y represent hydrocarbon residues, probably themselves containing other unsaturated linkages, and under the conditions of high pressure which were probably present during the formation of natural petroleum it is possible many of these four-membered rings are formed in a *single molecule, for example :*

$$\begin{array}{c} XHC-CH-CH_2-CH-CHX \\ | \quad\;\; | \quad\quad\quad\;\; | \quad\;\; | \\ YHC-CH-CH_2-CH-CHY \end{array}$$

an expression which, incidentally, indicates the manner in which the cyclohexane complex can also be produced by a similar process. So far as the chemistry of petroleum is concerned this is at present mere surmise, which must be investigated as soon as practicable. The view is, however, rendered plausible by the work which has been carried out at the imperial College during the past five years, which shows conclusively that the formation and stability of ring systems depends on the character of the groups attached to the carbon *atoms forming the rings, and is not merely* dependent, as Baeyer supposed, on the tetrahedral angle of the carbon atoms involved. It is probable also that a similar explanation may account for the 'naph-

thenes,' and will provide a general explanation of polymerisation and depolymerisation upon which it will be possible to base improved technical processes.

The composition of petroleums vary in accordance with their origin. Some are rich in aromatic hydrocarbons, and some are practically sulphur free; others contain so much of the last-named element as to render them unfit for use. The Kimmeridge shale oils are instances of the latter type, although doubtless if it were a paying proposition the sulphur could be readily eliminated from these products. The oil from the Persian, Mexican and Ohio fields contains sulphur which has to be eliminated during the process of refining. Among the sulphur compounds present mercaptans and thioethers have been identified, although whether they are present in the crude oil as such, or whether they are formed during the refining process is still an open question. Their removal by washing with liquid SO_2, an operation which is now carried out on a very large scale at the refineries at Skewen, is of interest.

It is clear, therefore, that the need for systematic research into the character of petroleum products is urgent, and it is gratifying to note that the Anglo-Persian Oil Company has established a research laboratory at Sunbury-on-Thames, in which the important principles underlying the industry have been and will be studied.

Dyestuffs and Intermediates.

Prior to the war Germany manufactured three-fourths of the dyestuffs required for the world's markets. Of the remaining one-fourth, one-half was made from German intermediates and was, therefore, dependent on Germany. Switzerland, although without a domestic source of raw materials, ranked second with about 7 per cent. of the world's production. Great Britain produced about one-tenth of her requirements, and France produced in French-owned and operated plants from 10 to 15 per cent. of her consumption. In order to meet the patent requirements of France and Great Britain, German manufacturers operated plants in those countries where the final assembling operations were completed. The small dye industry of the United States was almost dependent upon German intermediates. At the present time Great Britain produces 80 per cent. of the dyestuffs required for our own use, and we are, therefore, in a position to review the conditions which have led to this remarkable change and to consider the procedure necessary to strengthen it. It cannot be said that any fundamental advance in the chemistry of the dyestuffs has been made since Bohn discovered indanthrene in 1901, although great advances have been made since then in the preparation of new colours belonging to this and other series. Consequently the research work necessary in order to establish our position as a dye-making country has been mainly along known lines, involving the extension of reactions which had already been established rather than the discovery of new ones. Nevertheless it is no inconsiderable achievement for our research chemists to have established a position such as that indicated above in so short a space of time, for many of the preparations, the details of which could only be found in the patent literature, had to be worked out *de novo* and the correct conditions found for their adaptation to the technical scale. It is probably along the lines of decreased cost of production that research work in the mmediate future will be mostly engaged, and especially is this the case with the intermediate products from which the dyestuffs are derived. Moreover, the intermediate products are of the greatest importance for other industries, for example, the Fine Chemical Industry, the Perfumery, and the Explosives Industries, and any improvement in the processes for their mannfacture or the production of new compounds having enhanced value from the commercial point of view is of the greatest importance to all these industries alike. The parent substances of the intermediate products are the hydrocarbons of coal-tar or the coke oven by-products. The operations required to convert these hydrocarbons into the finished intermediates often involve many stages, any one of which depends for its cost on the purity and yield of the product. When large quantities are involved a difference of 1 per cent. in the yield may lead to a considerable difference in the cost of production, and it is obvious that reactions which yield their products in a state of purity sufficient for the market or further stage production without subsequent treatment make for reduced cost in production. There is thus a wide field for research into the improvement of technical methods which may well occupy the attention of our dyestuffs chemists for some time

to come. On the other hand the question of fundamental research into new processes, both for the preparation of new intermediates and new dyestuffs must not be lost sight of. The intermediate determines the character of the dyestuff, and it is always possible that a new intermediate may be discovered which will yield a dyestuff with just that difference of shade as to catch the public fancy, and which will lead to the replacement of the older dyestuff on the market. The sulphonic acids of the naphthol, naphthylamines and aminonaphthols are cases in point. These substances are used extensively for the preparation of azo dyes. There are a great number of these compounds theoretically possible, but only a few have found technical application owing mainly to the high cost of producing the others. The high cost is nearly always caused by poverty of yield, an objection which may be at any time removed by the discovery of an improved process. The same argument holds good for the dyestuffs themselves. It is futile to say that the vast field of organic chemistry has been thoroughly explored for the production of new types. At any moment one or other of the men or women engaged in fundamental research may repeat Bohn's discovery of 1901, and obtain a new compound which will be the forerunner of a new series of dyestuffs. It is perhaps too much to ask an industry which is struggling to hold its own to expend large sums on the prosecution of abstract research, most of which will be of no use to it, but it is not too much to expect that the industry will take every means to foster and encourage abstract research in our university institutions, and even to give some lead as to the direction in which its experience leads it to think that advances may be made. There is at present no organisation which can bring the manufacturers of dyestuffs and intermediates into touch with the work being carried on in our university laboratories, and it is possible that if at the present time a valuable discovery were to be made it would be unrecognised as such, and, following the usual course of academic research, would be published and thus lost to the country. What is required is a lead from manufacturers which will indicate the matters which they regard of importance but which they do not consider as likely to yield results sufficiently quickly to justify them in employing their own research staff for investigating them. This aspect is of all the more importance at the present time, when organic chemistry is entering on a new phase which will undoubtedly revolutionise many of the existing processes of manufacture. It is now recognised that the presence of a small quantity of a catalyst may either alter the course of a reaction or may lead it to proceed to completion where otherwise a totally inadequate yield would be obtained. The catalyst may either be added or the containing walls of the reaction vessel may act in this capacity. The well-known example of the oxidation of napthalene to phthalic anhydride by vanadium pentoxide is an example of this, but similar cases are continually recurring, and it has only recently been found that the classical method for preparing ketones by the distillation of the calcium salt of the appropriate acid can be utilised in the most unexpected directions if the thorium salt instead of the calcium salt is employed. It is perhaps appropriate to conclude this section by the following quotation from the United States Tariff Commission Report, No. 32 :—

'The acute shortage of dyes arising in the various dye-consuming markets, due to the disappearance of German dyes shortly after the beginning of the war, was soon followed by prices of unprecedented levels, while certain dyes were not to be had at any price. This dye famine threatened the activities of the vast textile industries, as well as other industries dependent upon dyes for their operation. The manufacture of dyes was soon entered upon in the United States, Great Britain, France and Italy, and each of these countries has developed a dye industry capable of supplying from 80 to 90 per cent. of its requirements and has, in addition, exported significant quantities of dyes since the war. As a result of this remarkable period of expansion and development the world's present capacity to produce dyes is nearly double that of the prewar period. This existing capacity to produce over and above normal requirements is resulting in an era of severe competition in the world's markets which may eliminate many of the plants not in operation. The German industry has certain advantages over the industries of the new producing countries, including cumulative experience, unified organisation for buying and selling, and lower manufacturing costs. The high post-war price levels of dyes ex-

ported from Germany would appear to indicate a strong probability of price reductions during the next few years. The commercial warfare which is likely to follow may involve the utilisation of such methods as full-line forcing and dumping such as was practised by the German chemical industry prior to the war. The retention of a tariff and other protective measures by the new producing countries will doubtless lead the German industry to form affiliations to establish branch plants in those countries. The war made clear the relationship of the coal-tar dye industry to the production of munitions, war gases, medicinals, and other essential products, and demonstrated the desirability of home dye production as a means to prevent shortage in times of war. This will probably result in an effort by the large industrial nations to retain dye industries of sufficient size to meet peace requirements and to provide for war emergencies. Reduced production costs and constructive research will be vital factors in the maintenance of their competitive place in the world's trade.'

This seems to sum up the situation with which we are at present faced.

PUBLICATIONS.

Our chemical publications grow apace—already they have outstripped in number and size those produced prior to the war. If one may take the Journal of the Chemical Society as representing a standard example, it may be noted that the number of pages published in 1914 was 2,909, whilst in 1923 the number was 3,441. This was reduced in 1924 to 2,698 pages, but rose again in 1925 to 2,986 pages. The drop in 1923-24 was not, however, due to lack of material, but to the exercise of necessary economy because the costs of printing have increased by 70 per cent. since the war, and the funds of the Society could not carry the increased expenditure. Until new sources of income could be created economy had to take the form of asking authors to cut down their papers to the greatest possible extent, and this had the effect of checking the advance for that year. Nevertheless during 1925, although authors continued to co-operate and still expressed their views and results in as small a space as possible, the steady rise in the amount of research work carried out in the country led to an increase in that year, showing that the new matter was due to new research, and was not the outcome of any remissness on the part of the Publications Committee.

The increase is still continuing, and is a welcome sign of the healthy condition in which research in chemistry stands at the present time. Still it means a Journal of well over 3,000 pages for 1926, and represents a condition of affairs which is shared by many other scientific societies.

There were many national scientific shortcomings revealed by the war, but it is probable that those in the chemical sciences loomed largest because they were the ones which had to be rectified by makeshift arrangements at the time, and although our national aptitude rose to the occasion, and we blundered through in our usual manner, yet when time for thought occurred the contract between our state of unpreparedness and the complete scientific equipment of our enemies was very marked, and gave cause for earnest consideration. The result has been a great increase in the numbers entering our chemical research schools, and the consequent output of an increased amount of new knowledge, all of which has to be recorded. The burden of publication has fallen, therefore, heavily on the societies dealing with chemistry, and more particularly on the Chemical Society, which is the chief means by which, through its Journal, new knowledge is published to the world.

The remedy is not obvious. The societies cannot increase their subscriptions without inviting loss of membership. Neither does it seem that much is to be gained by amalgamation, because each society deals with some branch of chemistry, and there is little or no overlapping or duplication. Amalgamation of the societies would not, therefore, decrease the costs of publication nor materially diminish the subscriptions necessary to meet these costs.

You cannot curtail papers beyond the point which enables the work described to be repeated, otherwise publication is valueless. You cannot say within wide limits that new knowledge is not worth recording, or that views expressed are best suppressed. The criticism has been raised that the modern tendency to issue short communications at frequent intervals leads to premature publication, and that much that is published has to be corrected in later papers, and it cannot be denied that recent experience has shown this criticims to be partly true. But it has been the custom of societies to accept short papers with more avidity than long ones, and in consequence authors have come to realise that the short communication stands more chance of ac-

ceptance than longer ones. The policy is in a sense wrong, because a series of short papers on the same subject necessarily leads to redundancy and frequently to a revision of the views expressed in earlier parts as the work progresses. The trouble seems to lie in the custom which requires an introduction to the series, the aim of which is to give the reader who has no interest in the experimental details a readable account of the scope of the work. If this 'introduction' were abolished and a 'summary and conclusions' placed at the end of the paper or series of papers, it would no doubt crab the literary style of the author and detract from the value of the communication as bed-side reading matter, but it would most certainly shorten the paper and would no doubt enhance its value from the scientific standpoint.

When it is remembered that there are some 23,000 scientific periodicals published throughout the world, the mind stands appalled at the prospect that will confront civilisation even in so short a time as 100 years hence, unless some general method of curtailment is agreed on. The space occupied by our ever-increasing libraries must cause alarm to those who contemplate the possibilities of the future. The agreement between the various societies dealing with chemistry to form a joint library at Burlington House means at the present time an increase of something like 800 volumes yearly—an increase which will augment as time goes on. In the not far distant future the library will occupy the whole of the space available in the society's apartments, and the same problem has to be faced by every other scientific society. Indeed, civilisation seems to be confronted with two ever-growing problems—the increase in its cemeteries and its libraries. The former, no doubt, will be solved by cremation. It is too much to hope that a judicious exercise of this method may also be applied to our libraries?"

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SIR OLIVER LODGE ON SCIENCE AND RELIGION.

Speaking the the Chapel of Manchester College, Oxford, on August 8, Sir Oliver Lodge said :—

"We are wondering where we are, whither we are going, whence we came. We are constantly asked questions such as 'What is matter?' Well, we have partially answered it and find that matter is composed of electricity—electric charges, small, very minute specks, revolving round each other in regular orbits, as the planets revolve round the sun, a great system of law and order throughout the universe, extending from the electron to the millions and millions of worlds extending away into infinity; not one law here, and another there, but one. Thus we get a sort of notion of what the Creator, the ruler, the producer, the designer, must be; that He is one, one great mind.

But the question next arises : What is electricity? It is made up of small particles called electrons and protons. We did not know of them 50 years ago; we do not know now what they are. We try to explain them as modifications of the ether of space—it is not worked out fully yet. I feel in my bones that you will be answered in that way, that electricity is a modification of the ether. What, then, is the ether? Answer me : What is mind?

The answer from the materialistic point of view has been indicated two nights ago by Professor Eddington. He showed as the results of his researches that for the most part the universe of matter does not exist as we know it. It is resolved into its electric components, which fly about in all directions. The temperature is too high, the conditions are such that matter has not organised itself into atoms such as we know them, but here and there are small bodies, too small to be hot, where there is ,as on the earth, the possibility of these coming together, grouping themselves into solar systems, and thus building up molecules and chemical ingredients and all the forms of matter that we see. They are merely built up out of the fundamental units, and some of these buildings are so complex that they are able as I should say to be utilised by, or manifest, as others say, the functions of life and mind and consciousness—all terms about which philosophers have written ever since archaic times. And so, as Eddington concluded in his lecture, some

of those material groups are assembled here in Oxford and are discussing the universe.

SHROUDED IN MYSTERY.

Don't let me for a moment be supposed to imply that Eddington is a materialist. He knows better. Materialism is one answer of science to the question : What is matter?—molecules with life and consciousness as epiphenomena. Then comes the question, What is God? Some would say : 'He is an idea thrown up by these aggregates of molecules.' Well, anyone able to believe that is very strong in his powers of credence. But you see, we cannot answer the ultimate question. We are up against mystery continually. The universe is still shrouded in mystery. We are probing the unknown and finding more and more of it. What is infinity? It is space without limit. What else is possible? What is time Was there a beginning? Will there be an end? Must it not be an eternity?

We cannot answer. We move about in worlds not realised. We know that the account of our rise from animal ancestry is only a very partial answer. We have instincts that tell us that our roots are in another order of things; that reality is not perceived by the senses, which carry us only a little way. All our discoveries are inferences by the power of the mind, and the thoughts and the plans and the designs are not matters of pulpy material in the skull. It is we ourselves who belong to a different order of existence—what we call the divine —who inhabit this collocation of matter for a time and then leave it behind and go on without it. Many have no doubt—it is strange that any should have a doubt; science has not yet answered that question —that men will survive the adventure called death. Is death the end of man?

Science has also not answered the question, 'Is man the highest being of whom we have cognisance?' But those are questions which may be regarded as questions to which we are getting the answers. The fact that we are asking those questions and want to know the answers, that we realise that there is a great problem in the universe, far beyond anything accessible to our animal senses—that possibility is itself a great thing to realise. But the eyes of our mind, if they were open and if we could see the vision of reality, would be blinded. It would be too much for us in our present state of development. We could not stand the beatific vision. Mercifully, things are screened from us in order that we may go about our business and do our daily work. That is our job for a time, but that is not the end. All this is means to a great end that we cannot grasp or fathom—'blank misgivings of a creature moving about in worlds not recognised.'

Sir Oliver Lodge recalled the point made by Lord Balfour in his speech recently—that after each of the last two 'academic' meetings of the Association there was a rapid advance in knowledge amounting to a revolution. That, he said, was true. Within a year of Lord Salisbury's address at the meeting at Oxford in 1894 radioactivity was discovered; in two years more Mm. Curie discovered radium; in 1899 Sir J. J. Thomson began the discovery of the electron, and before the century was finished the atom of matter had changed its character altogether and become an electrical atom, a modification of the æther. The whole of physics was revolutionised from that time. Then in 1904 the meeting was held at Cambridge. Lord Balfour's address was a glorification of the discoveries that had just been made, and the next year began with the speculations of Einstein, the discovery of relativity and the quantum, and, again, physics was revolutionised, and it began to appear that the universe, which is infinite, is infinite in an infinite number of ways. Space and time began to be analysed and made to give up their secrets. The old knowledge was not discarded, but it was so greatly supplemented as to be revolutionised.

And so Lord Balfour held out the augury that after this meeting of 1926 at Oxford some new great revolution would occur in science. 'What revolution?' asked Sir Oliver. Lord Balfour could not tell us. Neither he nor we have the faculty of prediction, but if I am to make a guess I would say that, whereas all through the 19th century and up to the present time we have been dealing chiefly with the material world, there now lies before us the discovery of the spiritual world. The spiritual world is no novelty in religion, but it is a novelty in science. It is not yet accepted, but the indications are that it will not be so very long before these questions, too, will be asked, and will begin to be answered. Does man survive? If he does, then the present man is not the highest being we have cog-

nisance of. If this life is a mere episode of the spiritual part of our existence, and if we are workers in another sphere, we shall become beings a little higher than anything we know of hitherto.

BEYOND THE GRAVE.

We are not limited to our animal existence; we go on with the adventure; we rise to become beings of a higher order, and once we have stepped over the limit, the grave, the gate of death, there is no end to the ascent. We are surrounded by intelligence; space is full of it. It does not make any appeal to our senses. We do not know of it in that way, but it is coming into touch with us; it is coming within our ken; we shall feel that we are not lonely, isolated, separated, but that we are surronded by a cloud of witnesses, and by a company of helpers in a marvellous spiritual world of which we have hitherto been scientifically ignorant.

I have not the weight of science behind me in saying this. Many will disagree, but I think that that kind of evidence is coming, and will be attended to, will force itself upon our attention, and that before the British Association meets again in Oxford our aspect of the universe will be revolutioned once more and beyond all previous scope and that we shall be in the position of islanders, or savages, who have for the first time come into contact with the higher race of white men, and learned that we were ignorant of the possibilities of humanity, and are as yet as nothing in the hierarchy of existence. It is my conviction that we shall find it out, and that we are beginning to find it out now.

General Notes.

POISONS AND PHARMACY ACTS ENQUIRY.

The Lord President of the Council has appointed a Committee, consisting of :—

E. A. Mitchell-Innes, Esq., C.B.E., K.C. (Chairman); L. G. Brook, Esq., C.B.; Sir Malcolm Delevigne, K.C.B.; F. W. Gamble, Esq.; Sir William M. Graham-Harrison, K.C.B.; Sir Donald MacAlister, Bt., .C.B., M.D.; E. T. Neathercoat, Esq., C.B.E.; Colin Smith, Esq.; G. Stubbs, Esq., C.B.E., F.I.C.; Sir William H. Willcox, K.C.I.E., C.B., C.M.G., M.D., F.R.C.P.; A. E. Young, Esq.; M. D. Perrins, Esq. (Home Office); Dr. E. W. Adams, O.B.E., M.D. (Ministry of Health), the two last-named being joint secretaries to the Committee; to consider and report whether any modifications are necessary or desirable in the Poisons and Pharmacy Acts—

(1) in regard to the conditions relating to the sale of poisons;
(2) in regard to the procedure for the modification or extension of the Schedule of Poisons to which the Acts apply;
(3) in the system of making and enforcing Regulations in regard to the keeping selling and dispensing of poisons;
(4) in regard to the Central Authority for the purposes of the Acts; and
(5) in regard to any other matters to which the attention of the Committee may be drawn.

The Committee have decided to take evidence on matters within their terms of reference. Any person, association or firm wishing to give evidence or place their views before the Committee should communicate as soon as possible with Mr. M. D. Perrins (Joint Secretary), Home Office, Whitehall, S.W.1. The Committee will inquire generally into the existing machinery regulating the sale (retail and wholesale), keeping, distribution and supply of poisons; any consideration of proposals for the inclusion in or exclusion from the Schedule of Poisons of any specific substance is *not* held to fall within the Committee's terms of reference.

SAFETY IN MINES RESEARCH BOARD REPORT.

The fourth annual report of the Safety in Mines Research Board, in respect of the year 1925, has just been published (H.M. Stationery Office, price 1s. net). The report is mainly devoted to brief accounts of the progress of the numerous researches which are being carried out either directly under the Board or committees of the Board, or at Universities and other centres with the aid of funds supplied by the Board. The Board has now two experimental stations, one at Sheffield for laboratory work, and one at Buxton (formerly at Eskmeals), chiefly for large-scale work. The scientific and technical staff numbers about 50. The total annual expenditure on there researches

approaches £50,000 a year and is mainly defrayed out of the Miners' Welfare Fund.

The subjects of research include problems relating to coal-dust explosions, fire-damp explosions, spontaneous combustion of coal, the safe use of electricity in coal-mines, mining explosives, safety lamps, devices for trapping dust generated by rock drills, falls of ground, wire ropes and the control of mine temperatures. Eleven reports were published by the Board during the past year, and a list is given of many other papers relating to the researches written by members of the staff and published in scientific journals, etc.

A report on the co-operative research which has been arranged between the Safety in Mines Research Board and the United States Bureau of Mines on many of these subjects during 1925 is given in an Appendix, and there is a note describing the organisation of mining research in the United States. The Report also embodies an account of the progress of the health enquiries carried on under the supervision of the Health Advisory Committee, notably the enquiries with regard to the injurious effects of certain rock dusts.

STANDARD ASBESTINE, ZINC OXIDE AND VARNISHES.

The British Engineering Standards Association has recently issued British standard specifications for zinc oxide (types 1 and 2) for paints (No. 254 of 1926), asbestine for paints (No. 255 of 1926), interior oil varnish (No. 258 of 1926). They contain clauses regulating the composition, together with standard reception tests, for the purchase of zinc oxide, asbestine, interior, exterior and flatting or rubbing oil varnish, and appendices giving methods of carrying out the tests.

These specifications have been prepared at the request of the paint manufacturers by a committee representative of both the buying and manufacturing interests, and as in the case of all British standard specifications, they will be reviewed as experience of their working or progress in the industry renders it necessary, and revised issues will be published from time to time. Among other specifications in hand which will be published as complete are the following :—Painting materials—boiled linseed oil, zinc oxide oil paste, barytes, red oxides of iron, red oxide of iron oil paste, lead chromes, prussian blues, lithophone, carbon black and gold size; ready-mixed linseed oil paints—white lead, tinted white lead, zinc oxide, tinted zinc oxide, black, green and red oxide of iron; and extra hard drying oil varnish.

SALT.

Record Production of Salt in Canada in 1925.

In 1925, the production of salt in Canada exceeded all previous records according to final statistics just issued by the Mining Branch of the Dominion Bureau of Statistics at Ottawa. Shipments during the year totalled 233,746 tons as compared with 207,979 tons produced in 1924. There was a considerable decline in value during the year, the average price for all grades being $6.04 per ton, as against $6.61 in 1924.

GYPSUM.

Canadian Gypsum Production in 1925 Highest on Record.

According to finally revised statistics, just issued by the Mining Branch of the Dominion Bureau of Statistics at Ottawa, gypsum production in Canada during 1925 totalled 740,323 tons, a new high record for this important Canadian mining industry. The value received by the operators was $2,389,891, or $3.23 per ton. In 1924, the shipments amounted to 646,016 tons, valued at $2,208,108. Gypsum rock quarried in 1925 totalled 705,852 tons, of which quantity 162,820 tons, or 23 per cent. was calcined.

NOTICES OF BOOKS.

The Paper Makers' Directory of all Nations. Over 1,000 pp. Price 21s. net. London: Dean and Sons, Ltd., 29, King Street, Covent Garden, London, W.C.2.

The international character of this Directory—the Red Book of the British Paper Industry—and the useful Buyers' Guide on pp. xiii-xxxviii, make it invaluable for bringing paper makers into communication with merchants, wholesale houses, newspaper proprietors, large printing firms, etc; chemical and colour manu-

facturers, etc., with paper makers and pulp manufacturers; china clay and fibre merchants, paper, pulp, and board agents, paper stock dealers, felt and paper machine wire manufacturere, etc., with paper makers, and a host of allied trades, not only at home but in foreign and colonial markets.

Being alphabetically arranged throughout, both as regards countries and mills, it is particularly easy of reference, while the list of mill productions under more than 400 trade headings is also classified alphabetically in three ways, under goods, country of origin, and name of firm.

Physical and Chemical Constants and Some Mathematical Fractions. By G. W. C. Kaye, O.B.E., M.A., etc., and T. H. L38/, M.A., Sc.D. Price 14s. net. Longmans, Green & Co., 39, Paternoster Row, London, E.C.

This is the fifth edition of these valuable tables, and contains new matter not present in the previous editions, such as that on isotopes and the mechanical equivalent of heat, while the book has been carefully revised and brought up to date. Among the subjects are, General Physics and Astronomy, Heat, Sound, Light, Electricity, Magnetism Rays, Mathematical Tables, etc.

Colloid and Capillary Chemistry. By Herbert Freundlich, Ph.D., Professor at the Kaiser Wilhelm Institute for Physical Chemistry, Berlin. Translated by H. Stafford Hatfield, B.Sc., Ph.D. XV + 884 pp. Price 50s. Methuen & Co., Ltd., 36, Essex Street, London, W.C.2.

This important work must have entailed considerable painstaking time on the part of the translator, who has been fortunate in having the assistance of a number of well-known scientific men, so that it can be considered an authentic reproduction of the thought and ideas of Professor Freundlich. Embodying, as it does, the matter appearing in the third German edition, it is quite up to date. There are a detailed subject index, an author index and table of contents.

Plant Products. By S. Hoare Collins, M.Sc., F.I.C. XIV + 262. Price 10s. 6d. net. Ballière, Tindall & Cox, 8, Henrietta Street, Covent Garden, London, W.C.2.

This is a second edition, the first having been written in the war period, and material alterations and addenda having become necessary. The important question of artificial fertilizers has been curtailed, being more adequately treated in *Chemical Fertilizers*, a companion volume. On the other hand, more space is devoted to the chapter on soils. The book, while following the plan of the first edition, is virtually a new work, and should find a place in the library of anyone interested in agriculture.

Organic Chemistry. By William Albert Noyes. Pp. XVIII., + 678. Price 3.50 dollars. New York: Henry Holt and Co. (19, West 44th Street).

Certain matters are succinctly dealt with by the author, and so he avoids what is considered over-elaboration of some writers, and leaves more space for discussing what he considers more important points. Methods of preparation, demonstration of structure, and general properties for a given class of compound follow. The more important compounds are dealt with at greater length. The book contains a detailed alphabetical index. It is a readable, interesting, and useful book for the student of chemistry.

There is an interesting and extended foreword by C. F. Cross. The work can be read and studied with interest by all connected with the paper-making, printing, and kindred industries.

A Text Book of Organic Chemistry (Historical, Structural, and Economic). By John Read, M.A. (Camb.), Ph.D (Zurich), B.Sc. (Lond.) Pp. 12 + 680. Price 12s. 6d. net. London: G. Bell and Sons, Ltd.

Professor Read has produced a well-written work in which science is dealt with in a manner calculated to secure and hold the attention of the reader. Besides, the book deals with the chemical resources of the Empire, contains numerous interesting experiments, and many illustrations, concluding with a table of atomic weights.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

18,862.—I. G. Farbenindustrie Akt.-Ges.—Manufacture of products of conversion of pericyannaphthalene sulphonic acids. July 28th.

19,073.—Clark, T. W. F.—Manufacture of metol. July 31st.

18,752.—Jessup, A. C. — Electrolytic manufacture of magnetism, etc. July 27th.

18,875.—Rohm & Haas Co.—Resinous reaction products of urea and formaldehyde. July 28th.

19,031.—Soc. of Chemical Industry in Basle.—Manufacture of compounds of gall acids. July 30th.

Specifications Published.

255,522.—Askenasy, Dr. P. and Elod, Dr. E.—Manufacture of arsenic pentoxide.

233,784.—Verein fur Chemische und Metallurgische Produktion. — Processes for obtaining high-percentage anthracene and carbozole from crude anthracene.

234,852.—Buchner, M.—Manufacture of hydrofluoric acid.

255,630.—British Dyestuffs Corporation Ltd., Perkin, W. H., and Bunbury, H. M.—Manufacture of intermediates of the anthraquinone series.

283,225.—Soc. of Chemical Industry in Basle.—Manufaeture of new vat dyestuffs.

236,170.—Verein fur Chemische Und Metalulrgische Produktion. — Processes for obtaining high-percentage anthracene and carbazole from crude anthracene.

Printed Copies of the full Published Specification may be obtained from the Patent Office, 25 ,Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

Abstracts Published.

251,932.—Alkaliarsenates, anti-monates, and stannates.—Vulcan Detinning Co., Sewaren, New Jersey, U.S.A. (not yet accepted).

A solution containing alkali arsenate and stannate is concentrated and cooled so as to crystallize out the arsenate, after which a further evaporation and cooling causes the crystallization of the stannate. The original solution may be obtained by dissolving a mass produced in refining metals such as old battery plates by means of caustic alkali, the alkaline product being treated with water, when arsenate and stannate dissolve, while anti-monate remains insoluble; or other materials such as ores may be treated with caustic alkali for the removal of arsenic, antimony and tin, the alkaline product being then treated as above described. Instead of crystallizing out the stannate after the removal of the arsenate, the solution may be electrolysed for the recovery of the tin. In either case the solution ultimately obtained comprises caustic and/or carbonated alkali and may also contain alkali chloride. The chloride may be separated by evaporation and crystallization.

252958.—Phosphoric acid.—Liljenroth, F. G., 14, Eriksbergsgatan, Stockholm, Sweden.

Hydrogen.—The products obtained by the interaction of phosphorus and steam at high temperature with or without the use of a catalyst are fractionally condensed whereby the phosphoric acid is obtained in concentrated condition. The prosphoric acid is condensed at about 100° C., or above preferably by passing the gaseous products through a tower possibly filled with packing and into which water is injected. As the uncondensed gases contain a small amount of phosphorus unoxidized by passage through the catalytic bed which may consist of iron, nickel, cobalt, ruthenium, rhodium, palladium, osmium, iridium, platinum, manganese, chromium, molybdenum, tungsten, uranium, copper, silver or gold or oxides thereof the steam is preferably condensed in two stages so that the phosphorus is obtained in the liquid condidition, that is at a temperature above 44° C. when it may be readily collected. The final condensation is effected at as low a temperature as possible in order to dry the hydrogen *remaining and may also be performed by* injecting water.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

470,431.—Signature of Charles H. Phillips for Chemical Substances prepared for use in medicine and pharmacy. Proprietary Agencies, Ltd., 179 to 181, Acton Vale, London, W.3. July 28th.

FLIPP.

169,620. Insecticides, disinfectants and deodorisers. Standard Oil Company. Constable Hook, Bayonne Hudson County, State of New Jersey, U.S.A. August 4th, 1926.

MELISKA.

169,543. Chemical substances prepared for use in medicine and pharmacy.—R. M. Wilkie, trading as R. M. Kilkie, 28, Hildreth St., Balham, London, S.W.12. August 4th, 1926.

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THIS WEEK—INDEX AND TITLE PAGE TO VOLUME 132.

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ANTAGONISTIC ACTION OF IONS IN THE COAGULATION OF COLLOIDS.

By DR. K. C. SEN, D.Sc.
(*Allahabad University.*)

About five years ago Weiser (*Jour Phys. Chem.* 1921, XXV., 665), published a paper on the antagonistic action of ions in the coagulation of sols and suggested that the antagonism was due to the cutting down of the adsorption of one coagulating ion by the second one. He also suggested that the adsorption of the stabilising ions might also be the cause of this behaviour, though without any experimental evidence. In a later paper (*Jour. Phys. Chem.*, 1924, XXVIII., 232), while discussing an article by Freundlich and Scholz (*Kolloidchem. Beihefte*, 1922, XVI., 267), on the same snbject, he seems to have practically given up the latter idea, and pointed that the antagonism was mainly cationic, and will be only observed when the two ions have widely different coagulating powers. Abont a year ago, I showed (*Jour. Phys. Chem.*, 1925, XXIX., 517), that this can hardly be a general fact, because in presence of suitable electrolyte pairs, the antagonism will be shown even though the cations are identical. It is gratifying to note that Weiser has accepted this view, and admits that "the critical values for mixtures of two electrolytes may rise above the additive value even when the precipitating ion of the two are identical, thus eliminating antagonism between precipitating ions."

In the same paper I predicted that mixtures like $K_4Fe(CN)_6$ + KCl will show antagonistic behaviour in the coagulation of arsenious sulphide sol. In a later paper (*Zeit. anorg. Chem.*, 1925, CIL., 139), this was shown to be actually the case. Weiser has extended these investigations and have also corroborated this (*Jour. Phys. Chem.*, 1926, XXX., 24). He has further found that a mixture of KCl + $BaCl_2$ shows less antagonism than a mixture of $K_4Fe(CN)_6$ + $BaCl_2$. Weiser admits that this is due to the greater stabilising action of ferrocyanide ions than that of Cl' ions, though he is not sure whether the cutting down of the adsorption of $Ba^{\circ\circ}$ ions by K° ions also plays a part or not. From the discussion, the following facts seem to have been established :—

1.—The antagonistic effect of two electrolytes like potassium chloride and potassium ferrocyanide with copper ferrocyanide and arsenious sulphide sols is due to the adsorption of similarly charged ions, namely, the ferrocyanide ions.

2.—With mixtures like sodium benzoate + NaCl, sodium benzoate + $BaCl_2$, and sodium benzoate + barium benzoate, there is a pronounced antagonistic effect with arsenious sulphide sol. With the mixture of sodium benzoate + NaCl, the antagonistic action is undoubtedly due to the benzoate ion. The antagonistic action is equally pronounced in the case of mixtures like sodium benzoate + NaCl and sodium benzoate + $BaCl_2$. In

this case, therefore, there is no need to assume any displacement of barium ion adsorption by sodium to account for the observed antagonism. With the mixture Na benzoate + Ba benzoate, the antagonism is greatest because the benzoate ion concentration is greatest. (Cf. Muherjce and Ghosh: *J. Ind. Chem. Soc.*, 1924, I., 213.)

It may be noted here that though purely cationic antagonism is not improbable, it has not been proved to exist as yet. Weiser has shown that the presence of potassinm ion cuts down the adsorption of barium ion in the case of arsenious sulphide sol, but it will be a mistake to connect the existence of the antagonistic behaviour simply with this fact. Thus I have found that the presence of potassium ion cuts down the adsorption of barium by manganese dioxide, but in the coagulation of this sol, there is no antagonism between the salts KCl and $BaCl_2$. Smilarly there is no antagonism between the salts K_2SO_4 and $K_2C_2O_4$ in the coagulation of ferric hydroxide sol, though the adsorption of one is cut down by the presence of the other. Hence, simply cutting down of the adsorption of one ion by another cannot explain the antagonistic behaviour of two electrolytes. When two coagulating ions are present, usually the adsorption of each is separately diminished, but the combined adsorption will determine the coagulating concentration of the electrolytes. Though the adsorption of each is separately diminished, the total adsorption of both the ions may be equivalent or greater than the adsorption of either of the ions when only one is present at the coagulating concentration. With manganese dioxde and potassium and barium chlorides, I have found that the combined adsorption of the cations is always greater than that when only one is present. If the presence of one cation cuts down the adsorption of another without itself being adsorbed much, then this case will be analogous to the "poisoning of catalysts," and we can expect cationic antagonism to take place. Experiments on the simultaneous adsorption of both K and Ba ions by arsenious sulphide are now in progress, and will show definitely whether the cutting down of the adsorption of one ion has anything to do with this antagonism.

Lastly, mention may be made of the phenomena of stabilisation of some sols on dilution, and acclimatisation of colloids. I have shown in previous papers that the stabilisation of sols on dilution can be observed with certain sols with a limited number of electrolytes (*Jour. Phys. Chem.*, 1924, XXVIII., 313; *Kolloid Zeit.*, 1924, XXXIV., 262). With trivalent and quadrivalent coagulating ions, less of the coagulating electrolyte is always necessary to coagulate a less concentrated sol of any substance. The only abnormal cases are found with a limited number of sols and a few univalent and one or two bivalent salts. A recognition of the effect of the adsorption of similarly charged ions at once explains this abnormality, and hence when due allowance is made for this, the general dilution rule first enunciated by the present writer jointly with others (c.f. Sen, Ganguly and Dhar, *Jour. Phys. Chem.*, 1924, XXVIII., 313) must be held to be of great generality. That the acclimatisation of sols is a direct consequence of the adsorption of similarly charged ions by the sols seems clear from the fact that only those sols which show abnormal behaviour on dilution, also show this acclimatisation phenomena, and further, this phenomena is observed only with electrolytes from which the similarly charged ions are likely to be adsorbed by the colloid surface. Consequently the following general statement which has been made in previous papers stands true :—The stabilisation of some colloids on dilution, the antagonistic action between pairs of some electrolytes on several colloids, and the phenomena of acclimatisation of sols, can all be explained by the same theory, and in all these cases, the influence of ions with the same charge as on the colloid particles must be recognised as of primary importance.

Chemical Laboratory,
Allahabad University.

THE SOUTH AFRICAN CHEMICAL INSTITUTE.

PRESIDENTIAL ADDRESS BY JAMES MOIR, D.Sc., M.A., F.R.S.S.A.

THE CHEMICAL CAUSE OR ORIGIN OF COLOUR.

I suppose it has to be recognised that a Society such as ours, existing in a small community and pioneering chemical science in a comparatively undeveloped country, has to fall hack on the expedient of making the same person serve twice as President.

However, from the point of view of the victim of this extraordinary arrangement (to quote Gilbert), the matter is not so simple, because the writing of a second Presidential Address, after one has exhausted all the originality one ever had on the first one, is a real problem.

I am precluded, too, from escaping by the usual " uitgang " by the fact that Professor Wilkinson has recently exhibited the progress of chemistry to another scientific body so excellently, and with such extreme comprehensiveness, that no one need try to follow this line for years to come. Another outlet might be to preach to one's colleagues on the necessity for unity in the profession, but I feel that this line must be abandoned also; there are many others who can do it much better than I.

I have decided to take the line of least resistance and treat you to an address on a branch of theoretical chemistry in which I am much interested. This subject is the chemical cause or origin of colour, on which I have been working since 1916. I have now got far enough with it to be able to propound a new theory which supersedes the older ones by being simpler yet more comprehensive, and it remains to see whether any series of facts turns up which cannot be explained by it.

My theory of colour depends on four postulates :—

1. When light strikes any object, electrons are dislodged from such of the atoms as have *free* electrons; those of carbon are not, as a rule, free, but oxygen and nitrogen generally have free electrons, as in X : O : Y, and after the dislodgment the atom which lost the electron is a positive centre of force.

2. These dislodged electrons may be caught by, or come under the attractive force of, a different positive centre.

3. If both the original and the positive centre occur in the molecule in such a way that their mutual distance does not alter much, the free electron belongs to both atoms, and revolves round them both in an elliptic orbit which grazes the outsides of the two atoms.

It is essential that the portion of the molecule concerned in colour-making be a practically rigid structure, without any internal rotation.

FIG. 1.

4. The rotation and the electron leads to the destruction of light of the particular wave-length that has the same number of vibrations per second as the number of rotations per second.

In addition to the postulates, one has to mention that the mathematics of the elliptic orbit are peculiar, so that the orbit can only arise under rather limited conditions, such as the fact that the electron must be hit out at right angles roughly to the line joining the two positive centres; the result is that at a given moment only a few of the molecules are correctly oriented towards the light, and it requires a reasonable concentration of the coloured substance in solution to exhibit colour.

The last step in the theory is that when a particular wavelength of white light is absorbed, the material exhibits the colour which is opposite or " complementary " to the colour of the absorbed light. Thus, if wave-length 400 is absorbed (which is the case when the elliptic orbit is small owing to the two active atoms being close together), *the substance appears yellow* (white light minus violet light); similarly, if wave-length 650 is absorbed (atoms 60 per cent. farther apart than in the first case), the substance appears green (white light minus red light); and intermediate values of the wave-length correspond to intermediate colours (500 = red-orange, 550 = purple, 610 = blue).

It is to be noted that the wideness of absorption bands as compared with emission-spectrum lines is mainly due to the molecule not being absolutely rigid.

To summarise, then, there is found to be *a relationship between the colour of a substance* and the difference between two active parts of the molecule of the substance. I have published elsewhere the rather complicated equation governing this relationship for all possible wave-lengths, but for practical purposes we can confine ourselves to visible colour, of wave-lengths greater than 350 and less than 700 micromillimetres.

For this range the equation is linear, *viz.*,

$$l - 82d - 20$$

in which l is the wave-length absorbed (micromillimetres), and d is the distance between the positive centres measured in a straight line, through the molecule and expressed in tenth-metres or Angström units (if both wave-length and distance are expressed in tenth-metres, the equation is: l' $820d$ 200). Thus, if d is 4, as in the case of alkaline hydroquinone, $l = 314$, and the substance is almost colourless, having an absorption band in the ultra-violet. The subjoined table gives standard calculated values of l, along with an example of a primitive substance corresponding in band and colour.

TABLE.

Value of— d	l	Colour	Example.
4.5	349	Yellow-straw	Glyoxal
5.0	390	Full yellow	Diazomethane Salicylaldehyde
6.0	472	Orange	Aminoacridine Oxyanthraquinone.
6.5	513	Salmon-pink	Aminoazobenzene
7.0	554	Rose	Fuchsine
7.3	579	Red-purple	Violuric salts
7.5	595	Violet	Resorufine
7.7	611	Blue-green	Indigo
8.0	636	Emerald-green	Indophenol
8.8	702	Olive	Quinhydrone

A primitive substance is one which has no side groups, *i.e.*, consists of the bare skeleton carrying the active groups. Most ordinary colours, however, contain side groups, such as methylated nitrogen atoms or naphthalene rings instead of benzene rings. The effect of such groups is to heighten the colour by acting as obstructions to the moving electron. The consequence is that the electrons, in order to get a permanent orbit, must go round the obstacles or through any hollow part of them; and that such electrons as do so are performing a larger and rounder ellipse than the normal. This larger ellipse involves slower movement, and consequently a higher colour. These extra groups of inactive and merely obstructive character are known technically as "loads." As a rule the effects of loading are small, say from 2 per cent. to 10 per cent., according to the size of the load.

The rigidity of the molecule has been mentioned already as being essential. As a rule this rigidity arises from the existence of double linkages between the elements intervening between the two positive centres. The earlier colour-theory, therefore, ascribed the production of colour to unsaturated or quinonoid linkages, which were called chromogens and chromophores.

You will notice that only a few colours are accounted for in the table; the explanation is that all other shades are mixed colours; thus blood-red is purple plus yellow; brown is red with some green; scarlet is pink plus yellow; olive is green with a little red; and so on.

The benzene ring is the commonest rigid structure for holding positive atoms at a fixed distance and so producing colour, or, more strictly, absorption. Examples of white benzene derivatives which would appear coloured if our eyes were slightly more sensitive to violet light are:—Sodium salicylate, resorcinol, phenylenediamine, oxindole, *m*-nitrophenol, and all the higher cyclic hydrocarbons, in which double linkages under strain render a pair of carbon atoms positive.

On the other hand, ethers of the fatty series such as methylal, $MeOCH_2OMe$, although they have two positive centres, show no absorption; other non-absorbing substances are:—Urea, hydrazine, oxalic acid, the sugars and glycerol, hydroxylamine, chloral hydrate, and paraldehyde. As the latter appears to have a rigid formula we must suppose that its oxygen atoms are too close together to give even a photographic absorption.

The whole of this work is founded on Sir W. Bragg's X-ray analysis of benzene and its derivatives, whereby it became possible to calculate the distance inside the molecules, with only one supposition, namely, that groups are attached straight in line with the benzene valency direction. The benzene ring is a buckled or cockled structure, and not a flat hexagon. Thus, para-phenylenediamine $H_2NC_6H_4NH_2$ is not really in a straight line, but has its middle bent at an angle of 70°, which brings the two nitrogen atoms comparatively near to one another (Fig. 2).

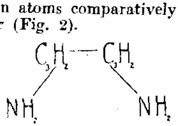
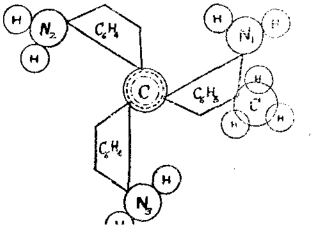


FIG. 2.

Similarly in the diketones MeCOCOMe, $MeCO.CH_2COMe$, and $MeCO.CH_2CH_2.CO$ Me, the diminution of colour is due to buckling of the molecules.

The colours in *inorganic* chemistry probably arise from the same cause; it is necessary to have two positive atoms and an electron in a state of some instability. Sulphur and iodine (as well as oxygen and nitrogen) are elements which, so to speak, have too many electrons for their valency, and thus are connected with colour phenomena. For example, mercuric iodide, IHgI, and mercurous iodide, IHgHgI, owe their different colours to the different distances of the iodine atoms from one another, and the colours agree roughly with the sizes of the atoms in question. In some other cases the solvent appears to take part in the phenomenon, its oxygen atom and the metal ion constituting the positive centres; examples are blue and pink cobalt salts. Other cases like silver oxide are phenomena of the solid state only, which is the same thing as saying that they are due to polymerisation. The case of graphite as opposed to diamond is similar. (By the way, a black substance is one that absorbs red, green and violet simultaneously.)

To conclude, I exhibit a diagram of the well-known dye fuchsine (rosaniline) drawn exactly to scale, so that the distance between the nitrogen atoms can be directly read off. All three distances are the same, but one of them is " loaded " by a methyl group; the two unloaded distances give a band at l = 543, and the " loaded " ones give a band at l = 550. The net result is a *single* band due to overlapping. It should be noted that the diagram is not perfectly flat, for the three benzene rings are in reality slightly foreshortened, since they form an angle of about 10° with the plane of the paper containing the central carbon atom, also the OH group of triphenylcarbinol is seen superposed on the central carbon atom."



SCIENCE AND TROPICAL DISEASES.

Ross Institute and Hospital for Tropical Diseases Opened at Putney Heath, London.

On July 15, in the presence of a distinguished company, H.R.H. The Prince of Wales opened the above Institute to commemorate the twenty-fifth anniversary of the discovery by Sir Ronald Ross of the method of transmission of malaria to human beings. The hospital is to carry on research work in the prevention of tropical diseases, and there are several laboratories, wards for patients suffering from tropical diseases, etc. The grounds extend to about four acres.

After receiving an address, the Prince of Wales delivered an interesting speech, reviewing the whole subject.

He said : " The opening of this institute, which I am very glad to perform, commemorates a definite achievement in the work which the British Empire has done for civilisation. Not the least important obligation which the development of that Empire has laid on the members of our race is the constant struggle against disease in all the varied forms it can assume in different climates and in different latitudes. The struggle is always fiercest in the tropics, where man, and especially the white man, is the continual prey of diseases from which we in this country are, comparatively speaking, protected by a more temperate climate; and perhaps the saddest page in the whole history of our Empire is that which tells of the terrible toll taken by plague and by fever of those who helped to build it.

Of all these tropical enemies, malaria has probably been the most deadly and elusive. But now, thanks to the achievement of one man, whose name we are perpetuating in this Ross Institute, its ultimate defeat is certain. (Cheers.) Only a few months ago I was able to see in the Sir Alfred Jones Laboratory in Sierra Leone not only the vital need for a campaign against malaria but also the remarkable progress which has already been made in it. Perhaps I am biassed by many visits to tropical and subtropical parts of the world where malaria is rife, and by having talked with so many men and women whose health has been shattered by a life's work in such districts, but I can think of no other single discovery

in recent times which will earn the deep gratitude of so many nationalities as the discovery made in India by Major Ross—as he was then on August 20, 1897. (Cheers.) The story of its subsequent development and of what it has led to is well known to you all. I need only summarise it in the words of a famous writer—'It is not too much to say that Sir Ronald Ross has made one-third of the world inhabitable.' (Cheers.)

Over a quarter of a century has elapsed since that epoch-making discovery, and this institute and hospital now stands as a memorial to the life-work of Sir Ronald and his colleagues. But it is not merely a passive memorial to work accomplished in the past; it is also, as Sir Charles McLeod has just reminded us, a very active centre for work to be done in the future. All who have any experience of the tropics will know that there is still a vast field for scientific medical research, and here, with all the resources that modern science can provide, such research can be effectively carried out, provided adequate funds are forthcoming. From this building may issue results which will bring back health to thousands who have lost it, or safeguard the lives of countless others threatened by unseen dangers in tropical lands. More than that, it may open out, for the use and benefit of mankind as a whole, huge districts which are at present denied to civilisation.

It is not surprising, therefore, that when the scheme for founding this Institute was first put forward, it immediately received widespread support. That support happily made its inception possible, and once the first financial obstacle was surmounted, its promoters lost no time in making it a reality. To the President, the Duchess of Portland, to Sir Charles McLeod and Mr. Shakespeare and to Sir Ronald and his two co-directors, Sir William Simpson and Dr. Castellani, the gratitude of all of us is specially due for the time and energy they have devoted to its execution. They and their fellow-officers of the Institute may well feel proud of the result of their labours and of the knowledge that they have called into being something which cannot fail to be of incalculable benefit to many generations.

It is with the sincere hope that further public support for the necessary endowment may be forthcoming, and that the labours of those who will work here may be blessed with every success, that I now declare the Ross Institute and Hospital open." (Cheers.)

In seconding a vote of thanks to the Prince of Wales, Sir Ronald Ross said they had been deeply interested in listening to his Royal Highness's remarks, especially in regard to his personal experiences connected with the ravages of malaria in the tropical and sub-tropical parts of the earth, which would bring vividly before everyone in the British Empire some sense of the terrible loss which that disease inflicted upon the world, and some idea of the need which existed for effort on the part of everyone to overcome it. He acknowledged on behalf of those associated with the institute the ready and generous assistance given to them by more than one thousand contributors, headed by the Prince of Wales. Many of these were scattered throughout the whole British Empire and even beyond it. So far, no less than 15 of our tropical Dependencies and eight rulers of States had helped them; hundreds of companies and business houses had added their names to their list; and many private persons had assisted them out of their own large benevolence, and sometimes, indeed, out of their own humble incomes. (Cheers.) Sir Ronald added that he was particularly grateful to the Prince of Wales for the very kind manner in which he had referred to his humble work, and he thanked them for the honour they had done him in naming the institute after him.

ELECTRICAL POWER GENERATION.

The Extensions at Barking.

By A Well-Known Engineer.

National electrification and the super-power station principle, whether for good or ill, continues to occupy much attention, and a new station is now to be built at Chiswick (London), at a cost of £2,500,000, while the new station at Barking, the first section of which (100,000 K.W.) was opened only last year, is to be greatly extended. Full details are not yet available, but a contract has been placed with Messrs. International Combustion Ltd., of London, amounting to over £750,000, for the entire steam generation plant for a second section of 100,000 K.W., which is to include pulverised fuel firing.

We understand that the installation will include 10 "Babcock and Wilcox" water tube boilers, 16,500 square feet heating sur-

face, each fitted with superheater of 6,500 square feet, feed water economiser of 6,100 square feet, "Usco" multiple plate air heaters of very large size, 18,600 square feet, "Lopulco" pulverised fuel equipment, including 15-ton per hour super- "Raymond" pulverising mill with exhauster and cyclone separator, and "Murray-Usco" water-cooled fin tube walls of 6,500 square feet, the whole forming ten separate self-contained steam generating units. Further, each of the combustion chambers will have a volume of 10,800 cubic feet, which will correspond to 16,800 B.Th.U. per cubic foot on normal rating, with 24,000 B.Th.U. per cubic foot maximum, and in addition to the "Murray-Usco" tubes and the usual "Lopulco" water screen, wil be fitted with the "Usco" suspended firebrick arch and 11 separate pulverised fuel burners on the latest fish-tail principle. Also the installation will include five steel chimneys, one for each two boilers, provided with grit catcher, an array of "Bailey" boiler house control instruments, boiler feed pumps, and 30 forced or induced draught fans, electric drivne.

The fact that pulverised fuel firing will be employed is particularly interesting because the first section of the station is at present being operated entirely with mechanical stokers of the travelling grate type. The relative advantages and disadvantages of the two systems seems more complicated than ever, while also both feed water economisers and air heaters are included for the new plant, which is rather unusual in modern pulverised fuel practice.

The "Usco" suspended firebrick arch is now making considerable progress, not only for mechanical stoking, many installations having been supplied in great Britain by the Underfeed Stoker Co., Ltd., but also for pulverised fuel and different types of metallurgical furnace, while it is of particular interest to the glass, ceramic, and chemical industries.

General Notes.

DISINFECTANT FLUID FOR SOUTH AFRICA.

We have been advised that his Majesty's Senior Trade Commissioner in South Africa (Mr. N. Elmslie) reports that the South African Railways and Harbours are calling for tenders to be received by the 23rd September, 1926, for the supply of disinfectant fluid.

Firms desirous of offering British made disinfectant can obtain information regarding this call for tenders upon application to the Department of Overseas Trade, Room 52, 35, Old Queen Street, London, S.W.1., quoting reference number B.X.2796.

MESSRS. VICKERS LIMITED.

Avions Michel Wibault, of Billancourt, Paris, have received an order for their all-metal monoplanes from the French Government. The machines are similar to those being built by Messrs. Vickers ta Weybridge for a Foreign Government.

CANADIAN OFFICIAL MINING NOTES.

The Mines Branch of the Dominion Department of Mines at Ottawa has just issued the Final Report of the Peat Committee appointed jointly by the Governments of the Dominion of Canada and the Province of Ontario.

Copies of this publication may be obtained directly from the Department of Mines, Ottawa, from the Ontaria Department of Mines at Toronto, or from the Natural Resources and Industrial Information Branch, the Canadian Building, Trafalgar Square, London, S.W.1.

CANADA'S COAL PRODUCTION IN 1925.

The Natural Resources Intelligence Service at Ottawa reports that during 1925 Canada produced 13,134,968 tons of coal, valued at \$49,261,951, as compared with 13,638,197 tons valued at \$53,593,988 in 1924, thus showing a decrease of 3.5 per cent. in quantity and 8 per cent. in value. There were 16,832,435 tons imported—about the same as in the previous year.

Nova Scotia produced only 3,842,978 tons of coal in 1925 as compared with a total of 5,557,441 tons in 1924, the decreased output being largely accounted for by the strike in that Province which occurred in the earlier part of the year. The Province of Alberta held the premier position with an output of 5,869,031 tons, which was 679,302 tons above the 1924 production.

INSTITUTE OF PHYSICS.

The sixth annual report shews that the Corporate Membership at the end of 1925 was 441, as compared with 428 in 1924. During the year 10 Fellows were elected, including 5 transferred from the class of

Associates, and 22 Associates. The number of Ordinary Members has increased by 1 only. The total membership roll at the end of the year was 530, made up as follows:—

Honorary Fellow	1
Ex-officio Fellows	3
Fellows	294
Associates	143
Corporate Members	441
Ordinary Members	89
Registered Students	10

SOIL ACTION OF CYANAMIDE.

The action in the soil of Calcium Cyanamide differs from that of other nitrogenous fertilisers, on account of the fact that it has to undergo a series of changes before its nitrogen content becomes available for the use of the crop. It must not be imagined, however, that the plant does not receive benefit from Cyanamide at an early stage of growth. A proportion of the nitrogen becomes available shortly after the fertiliser has been applied to the soil, while the remainder is steadily liberated for the use of the crop during the growing season.

When calcium cyanamide is applied to the soil, it is first of all rapidly converted into urea, an organic compound that is not liable to be washed out by heavy rains. The urea so formed is converted into other organic forms, which are, in turn, changed into ammonium compounds, which are finally nitrified.

As a practical result of this series of changes, it may be said that calcium cyanamide possesses an action that is intermediate between that of quick-acting nitrogenous fertilisers and that of ordinary organic manures.

By reason of the difference between the soil actions of cyanamide and other nitrogenous fertilisers, there is frequently considerable advantage in applying cyanamide in the autumn season instead of in spring. When calcium cyanamide is applied in the autumn it continues to feed the crop steadily throughout its growth, and, on account of the many changes in composition that it undergoes in the soil there is little danger of any material loss of nitrogen in the drainage waters.—*Crops and Grass Lands.*

PROCEEDINGS AND NOTICES OF SOCIETIES.

ROYAL INSTITUTION OF GREAT BRITAIN.

At the Meeting held on February 12, 1926, Sir Ernest Moon, K.C.B., K.C., LL.B., Manager and Vice-President, in the chair, the following paper was read:—

Chemistry of Red and Blue Colouring Matters of Flowers. By Robert Robinson, D.Sc., F.R.S., Professor of Organic Chemistry, University of Manchester.

Prior to the work of Richard Willstätter, the publication of which began in 1913, there was a striking deficiency in our knowledge of the nature of the bright red and blue, violet, purple, mauve and magenta colours of flowers, fruits and blossoms. These water-soluble anthocyanin pigments occurring in the cell sap were already distinguished from the water-insoluble plastid pigments, such as carotin, xanthophyll and chlorophyll, which occur alongside protoplasmic bodies, and many of their superficial reactions were known. Glenard (1858), Senier (1878), Heise (1889), and Glan (1892) examined various imperfectly purified anthocyanins and found these to contain carbon, hydrogen and oxygen only; whilst Griffiths (1903) obtained the geranium pigment in a crystalline condition, and came to the same conclusion regarding its elementary composition. Moreover, the botanist Molisch showed in 1905 that in many cases the pigments exist in the living plant in a microcrystalline condition, and followed up this observation by demonstrating the crystallisability of several of these colouring matters on a small scale outside the plant. Molisch considered that the crystalline pigments contained sugar in a combined form, but when Grafe succeeded in reproducing Molisch's experiments on a larger scale with pelargonium petals, he failed to recognise that the crystalline colouring matter he had obtained was a glucoside. Willstätter and Everest (1913) examined anthocyanins in general, and the pigment of the cornflower in particular. They found that the anthocyanins are glucosides having both basic and acidic properties. The anthocyanin of the blue cornflower they called "cyanin," and showed that it exists in the plant as its potassium salt. It was, however, isolated by taking advantage of its power of forming compounds with acids rather than with

alkalies. These salts—for example, potassium cyanin and cyanin chloride—could be crystallised, the latter with much the greater ease. The action of boiling 20 per cent. hydrochloric acid on cyanin chloride splits off the sugar groups and gives glucose (2 mols.) and cyanidin chloride, which crystallises from the solution. The name "anthocyanidin" is applied to all the sugar-free pigments which can be obtained by detaching sugar from the anthocyanins. Only in the case of the colouring matter of the skins of black grapes is the anthocyanin—namely, oenidin—supposed to be accompanied in nature by the corresponding anthocyanidin — namely, oenidin. Anthocyanin chlorides are much more soluble in water, thus partaking of the character of the sugar contained in their molecules, than are the anthocyanidin chlorides. The latter are completely extracted from aqueous solution by amyl alcohol, whilst the anthocyanins are only removed to a certain extent, usually to a very small extent, by this solvent. Subsequent work showed that cyanin is contained in red as well as blue flowers, and the following figures give the percentage of the colouring matter in the dried petals: Blue cornflower, 0.75; deep violet-blue cornflower, 3.6; deep bordeaux cornflower, 13-14; deep red dahlia, 20; *Rosa gallica*, 2. About 50 per cent. of the amount present in deep red dahlia petals can be isolated in the following manner. The fresh flowers are extracted with acetic acid, methyl alcoholic hydrochloric acid, and 1½ volumes of ether being then added. This precipitates the chloride, which is insoluble in ether, and the salt may then be separated and crystallised in the ordinary manner from a solution in 7 per cent. hydrochloric acid. It should be added that this process is usually straightforward owing to the high percentage of colonring matter in the flowers, a tribute to the effective work of the florists. Willstätter and Nolan, who prepared cyanin chloride from petals of *Rosa gallica*, showed that cyanidin chloride had the composition $C_{15}H_{11}O_6Cl$. Willstätter and Bolton isolated the anthocyanin, pelargonin, from the scarlet pelargonium, and found that the sugar-free pigment, pelargonidin chloride, had the composition $C_{15}H_{11}O_5Cl$; whilst Willstätter and Mieg obtained delphinin from the wild larkspur (*Delphinium consolida*), and found that it could be degraded to delphinidin chloride, $C_{15}H_{11}O_7Cl$. Every anthocyanin pigment which has been closely examined up to the present time has been found to be derived from one of the three anthocyanidins already mentioned, and the variety of flower colours is due to what may be described as the various exterior fittings of the molecules, as well as to the nature of the sap. If the latter is acid the colour tends to be red, if it is neutral the flower may be violet or purple, and if it is alkalescent the flower will be blue. Anthocyanins derived from pelargonidin occur in the scarlet *Pelargonium zonale*, the purple-red summer aster, the scarlet *salvia*, and in radishes. Cyanidin derivatives are very widespread, and have been detected in the cornflower, rose, dahlia, chrysanthemum, aster, peony, poppy, and in the fruits of the cherry, cranberry, and sloe, as well as in many other flowers, fruits and berries. Delphinidin is obtained from the anthocyanins of grapes and bilberries, and of the flowers of delphinium, hollyhock, petunia, wild mallow and viola. It is obvious that the problem of the molecular structure of the anthocyanins must be attacked by way of that of the simpler anthocyanidins, and in this matter conjectures confirmed by crucial experiments played a leading part. In the first place the analogy in composition between the anthocyanidins and the yellow plant colouring matters of the flavone and flavonol series could not be overlooked. Thanks to the labours of A. G. Perkin, von Kostanecki, and other chemists, we already possessed a knowledge not only of the wide distribution of these anthoxanthins in nature, but also of the details of their molecular structure. They are all of them derivatives of flavone, $C_{15}H_{10}O_2$, a compound which was synthesised by Kostanecki, and subsequently discovered by Müller to be the chief constituent of the farina of *Primula pulverulenta*. The other naturally occurring flavones have OH instead of H in several of the possible positions, and this substitution confers on them a weakly acidic character. It should be noticed that many of the hydroxylated flavones are weak bases and form readily decomposable salts with strong acids. We pass in review the established constitution of a few of the members of the group. Chrysin, $C_{15}H_{10}O_4$, from poplar buds has OH instead of H in positions 5 and 7; apigenin from parsley has the formula $C_{15}H_{10}O_5$, and the OH groups are in 5, 7

and 4′; luteolin from weld is $C_{15}H_{10}O_6$, and has OH groups in 5, 7, 3′ and 4′. Scutellarein from *Scutellaria altissimma* has its four OH groups in 5, 6, 7 and 4′. The flavones with an OH group in position 3 are called flavonols, and are more widely distributed than the flavones. Kæmpferol, $C_{15}H_{10}O_6$, has OH groups in 3, 5, 7 and 4′; it can be obtained from *Delphinium consolida*. Quercetin, $C_{15}H_{10}O_7$, with OH groups in 3, 5, 7, 3′ and 4′, is found widespread in nature. Derivatives of it occur, for example, in the inner bark of *Quercus discolor* Ait., in the leaves of *Eucalyptus macrorhyncha*, in rue, capers, buckwheat, clover flowers, cotton flowers, wallflowers, horse-chestnut, etc. Myricetin, $C_{15}H_{10}O_8$, with OH groups in 3, 5, 7, 3′, 4′ and 5′, is obtained from *Myrica nagi*, the ever-green box-myrtle of China, and other plants. All these flavones and flavonols have been artificially prepared in the laboratory, and, so far as is known, they all occur in the plant in combination with sugars. In order to appreciate the analogy in composition between the flavones and anthocyanidins, it is merely necessary to note that luteolin combines with hydrochloric acid to form a hydrochloride which has the same empirical formula, $C_{15}H_{11}O_6Cl$, as cyanidin chloride. Now when luteolin is fused with caustic alkalies its molecule is destroyed, but not so completely that none of the fragments can be recognised. The middle ring of atoms is wholly broken up by this vigorous treatment, but the benzene rings to some extent withstand the strain. The products which can be isolated are called phloroglucinol and protocatechuic acid; they are substances which can be artificially prepared in several different ways, and the position which they occupy in the system of organic chemistry is perfectly well understood. The first indication that the hypothesis of a close relation between the flavones and the anthocyanidins is correct was the fact that when cyanidin chloride was fused with alkali it also yielded phloroglucinol and protocatechuic acid.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

At the monthly Council meeting on July 26, Lord Desborough presiding, several chemical matters were considered.

Mr. Dampier Whetham reported that Dr. Voelcker had brought before the Committee a number of cases of interest which had been referred to him by members since the last meeting. These concerned :—

1.—The use of biscuit dust, a by-product from a biscuit factory, and containing a quantity of sugar. It costs £12 per ton and no objection could be taken to its use for chickens provided it were employed in small amount only.

2.—Finely divided carbonate of lime (containing 77.13 per cent. of carbonate of lime), and costing only 12s. 6d. per ton delivered.

3.—Shoddy—the use of which was objectionable on account of the quantity of weed seeds (black medick) occurring in it, and which seeds were capable of germinating and making the land foul.

4.—Phosphatic guano. This, invoiced at £8 15s. per ton, was found to contain 54½ per cent. of phosphates with nearly 3½ per cent. of ammonia, and the price was not out of the way.

5.—Hide dust, the refuse of a tannery. Though the material was in finely divided condition and contained nearly 8 per cent. of nitrogen, this latter was not in a readily available condition, and the material must necessarily work slowly.

6.—A soil from the South Coast where great difficulties were found in growing plants in a garden. This was hardly to be wondered at seeing that the analysis showed 89 per cent. of the dried soil to consist of sand, and that the amount of lime was .18 per cent., that of phosphoric acid .06 per cent., and that of potash .08 per cent. only.

7.—A case in which a member had given, to sheep, beans of various kinds which had been "thrown out" from purchases of seeds. The purchaser had been assured that no castor bean was present, but shortly after giving to some 30 sheep about ¼lb. each of the beans they were all taken violently ill. On examining the beans, Dr. Voelcker found there to be quite half a dozen different kinds, and of foreign origin.

The recognition of these mixed beans needs special experience, and the properties of many of them, indeed, are not definitely known. The danger of using Java beans and some varieties of what are sold as "Rangoon beans" is generally recognised. Dr. Voelcker cannot do more than emphasise the risk that feeders of stock run in buying such odd lots of unknown foreign beans.

8.—Adulteration of "fourths" with coffee husk and oat husk. "Fourths" are an offal of wheat, and if they contain anything not the product of wheat, the presence

of the same must be declared. A member of the Society in the Eastern Couuties purchased from a local grocer, under the name of "fourths," a material which was found, on analysis and microscopical examination, not to be genuine wheat offal, but to have a large admixture of coffee husk (parchment) and oak husk. The former is a worthless and indigestible material containing much fibre. The analysis showed that there must have been quite 25 per cent. to 30 per cent. of it present; the fibre amounted to 13.7 per cent., whereas genuine "fourths" would only have had about 5 per cent. The price charged was 10s. per cwt., retail.

It is a matter for satisfaction that under the new Fertilisers and Feeding Stuffs Bill the sale of such a material as the above without declaration of its composition and nature would be treated as a criminal offence.

LIEGE MEETING OF THE INSTITUTE OF METALS.

At the Liége Meeting of the Institute of Metals, to be held on September 1-4 next, the following papers will be submitted :—

The Deformation of Tungsten Crystals. By C. J. Smithells, D.Sc., H. P. Rocksby and W. R. Pitkin.

A Comparison of Static and Dynamic Tensile and Notched-Bar Tests. By Prof. Kôtard Honda, Sc.D.

The Constitution and the Physical Properties of the Alloys of Cadmium and Zinc. By C. H. M. Jenkins, B.Sc., A.R.S.M.

Some Further Experiments on the Behaviour of Single Crystals of Aluminium under Reversed Torsional Stresses. By H. J. Gough, M.B.E., S. J. Wright, B.A., and D. Hanson, D.Sc.

Silumin and its Structure. By Buntaro Otani.

The Primitive Copper Industry of America. Part II. By G. Brinton Phillips, A.B.

The Constitution and Age-Hardening of Some Ternary and Quarternary Alloys of Aluminium containing Nickel. By Kathleen E. Bingham, M.Sc.

The Constitution and Structure of the Commercial Aluminium-Silicon Alloys. By A. G. C. Gwyer, B.Sc., Ph. D., and H. W. L. Phillips, B.A., A.I.C. With an Appendix upon *The Properties of the Modified Aluminium-Silicon Alloys.* By D. Stockdale, M.A., Ph.D., and I. Wilkinson, A.M.C.T.

Some Mechanical Properties of Silicon-Aluminium Alloys. By J. D. Grogan, B.A.

The Action of Hydrogen on Hot Solid Copper." By Cyril Smith, B.Sc., D.Sc., and Professor Carle R. Hayward, S.B.

The Development of the Use of Nickel in Coinage. By Captain F. R. Barton, C.M.G.

Season-Cracking in Arsenical Copper Tubes. By A. Pinkerton and W. H. Tait.

Thermal Anomalies of Certain Solid Solutions. By Professor P. Chevenard.

Preliminary Experiments on the Copper-Magnesium Alloys. By W. T. Cock, B.Sc., A.I.C., and W. R. D. Jones, M.Sc.

Bronze Worm Gear Blanks Produced by Centrifugal Casting. By F. W. Rowe, B.Sc.

An Account of the Non-Ferrous Metals Industry in the Liege District. By L. Boscheron.

The meeting, which will be largely attended by metallurgists from all parts of the world, will include—in addition to the reading and discussion of papers—visits to works, receptions by the Burgomaster of Liége and the Association of Engineers, and excursions to the Belgian Ardennes. Approved applicants for Membership, as well as Members, may attend the Meeting and other functions.

Memhership particulars may be obtained from Mr. G. Shaw Scott, M.Sc., 36, Victoria Street, London, S.W.1.

EFFECT OF ELECTRIC FIELD ON THE SPECTRAL LINES OF ZINC AND CADMIUM.

By Yoshio Fujioka.

(*Abstract from Scientific Paper, Institute of Physical and Chemical Research, Hongo, Tokyo.*)

A few years ago the effect of electric and magnetic fields on the spectrum of mercury was examined very precisely by Hansen, Takamine and Werner. They found many forbidden lines which appear under the special conditions, violating the rule of selection. The mercury line $1S\text{-}2p_1$ ($\lambda = 2270$) which simply violates the rule of selection for the inner quantnm number, was observed either by the secondary effect of the magnetic field or by means of the condensed discharge; and soon afterwards this line and another line $1S\text{-}2p_3$ ($\lambda = 2655$)

of the similar character were observed, the former of the branched arc and the latter by the condensed discharge. By using similar method, the analogous lines for zinc and cadmium were observed by Foote, Takamine and Chenault and by Fukuda.

The forbidden lines which violate the rule of selection for the azimuthal quantum numbers, were first observed in the spectrum of mercury under the effect of the electric field and many regularities were found with respect to their appearances. Recently Fukuda has observed the same forbidden lines of mercury excited by the heavy current discharge. Further, he and his co-workers have modified his method and extended it to other metals, and succeeded to excite also the forbidden lines for zinc, cadmium, etc., with very large current density. In these cases, the heterogeneous electric field due to the clouded ions maintaining the current, was supposed to give rise to the appearance of forbidden lines. The excitation of them under the homogeneous electric field, however, was not carried out except in the case of mercury. In the present work the effect of the homogeneous electric field on the zinc and the cadmium lines was studied by using the ordinary Lo Surdo method. Many combination lines such as *pp*, *pb*, *pc*, and *pf*, were observed up to $2p$-$7q$, though it is, of course, still too limited a range as compared with that for the case of mercury owing to the difference of the character of the metals.

Quite recently, when this paper was in the course of publication, Schüller published a new method to examine the Stark effect, together with a fine photograph of the effect on the zinc lines. Although the results are not given in detail, the general feature seems to be the same as that of the present author. Schüller's new method is expected to afford a great service for the work in this line.

SUMMARY.

1.—Stark effect for zinc and cadmium was examined by the ordinary Lo Surdo method.

2.—Lines of diffuse series were found to be displaced towards the less refrangible side in the electric field.

3.—Many forbidden lines appearing in the electric field were observed and the relative intensities of them to the lines of diffuse series were measured although very roughly and discussed.

4.—Several new energy niveaus were determined.

NOTICES OF BOOKS.

Transactions of the Royal Canadian Institute, No. 34, Vol. XV. Part 2.

The contents include (1) The Nature, Cause and Prevention of Nervous Breakdowns, by Lewellys F. Barker; (2) Maturation and Conjugation in Spirogyra (with numerous plates), by Francis E. Lloyd; (3) A List of the Midibranchiate Mollusca recorded from the Pacific Coast of North America, by Chas. H. O'Donoghue; (4) The Meuretic Species of the Genus Rhaphium Meigen (Dolichopodidæ Dipt), by C. H. Curran (5) Representation of the Branches of an Algebraic Function of Several Variables, by J. C. Fields.

Potentiometric Titrations. By DR. I. M. KOLTHOFF (Conservator of the Pharmaceutical Laboratory of the State University of Utrecht, Holland), AND N. HOWELL FURMAN, Ph.D. (Assistant Professor of Chemistry, Princeton University, Princeton, N.J., U.S.A.). XII. + 346 pp. Price 22s. 6d. net. London: Chapman, Hall and Co., Ltd., Henrietta Street, Covent Garden.

In the Preface the authors point out that they confined their attention to the Potentiometric Branch of the subject, so that only indirectly is "Conductometric" Titrations referred to by them. They disapprove of the method of several authors, who refer to both branches under the comprehensive title of "Electrometric Titrations." The present work has its general as well as its particular application, and the authors may feel pretty confident that they have succeeded in one of their objects, namely, to prove that analytical chemistry is something more important than an empirical branch of chemistry.

U.S.A. BUREAU OF STANDARDS OFFICIAL PUBLICATIONS RECEIVED.

Zinc in 1924 (*Smeltor Report*). By C. E. SIEBENTHALL AND A. STOLL. Price 5 cents.

Lime in 1924. By G. F. LOUGHLIN AND A. T. COONS. Price 5 cents.

[NOTE. *In the first page (97), of the article by Mr. Hawksworth Collins, B.A. (Camb.), published in our issue of August 13 last, some lines were displaced in part of the issue, so we reprint the first page with the matter duly adjusted.*—ED., CHEMICAL NEWS.]

THE LAW OF RELATIVE VOLUME (*Continued*).

THE PART-VOLUME 5.02.

By HAWKSWORTH COLLINS, B.A. (Camb.).

The volume 5.02 *occurs more often than any other in the demonstration of the laws of heat of formation and relative volume, and it always represents the volume of a tetrad.*

This is a matter which could not possibly have been foreseen by anyone, much less could it have been hypothesised. It is a proof that the laws are correct, because it is a definite discovery obtained unexpectedly from previous discoveries.

In other words, the laws of heat of formation and relative volume are two regularities. If these regularities are only imaginary, and not real, *i.e.*, if they are merely the result of juggling with figures, it would be impossible to discover any other regularity within them. A regularity can only be discovered within a regularity if the latter is real and not imaginary.

The numbers in the last columns of the Tables refer to substances in this and the two preceding papers.

Table XVI. gives the cases in which two volumes of the same element differ by 5.02.

TABLE XVI.

		Volumes				Difference.	Refer to Nos.
(248)	Oxygen	7.53	-	2.51	=	5.02	80, etc.
(249)	Sulphur	15.53	-	10.51	=	5.02	93, 74.
(250)	Iodine	32.77	-	27.75	=	5.02	148, 150.
(251)	Selenium	21.29	-	16.27	=	5.02	284, 285.
(252)	Bromine	23.09	-	18.07	=	5.02	237, 286.
(253)	Neodym	20.60	-	15.58	=	5.02	287, 288.
(254)	Fluorine	20.72	-	15.70	=	5. 02	

(These last volumes will be supported when an opportunity occurs of demonstrating the structure of an atom of fluorine.)

In addition to the fact that the above elements have each two volumes differing by 5.02, it is a fact that all these seven elements are in either the sixth or seventh columns of the Periodic Table. (The column containing the gases of zero-valency does not come into the matter.) The probability that any one of them would be an element which happens to come in one of these two columns is 2 : 7. Therefore, the probability that all seven would accidentally be elements which come in these two columns is $2^7 : 7^7 = 1 : 6434$.

This is supposing there are only seven columns. If there are nine, not including the zero-column, the probability against its happening by accident wonld be more than 70,000 : 1.

This is another regularity appearing within a regularity, and is therefore another proof that the law is correct.

The reason why these elements must come in the higher columns is evident from preceding papers, but cannot be discussed now.

The first four in the Table are the only ones whose structures have so far heen demonstrated in the *Chemical News*, and in each case 5.02 has been shown to be the volume of a tetradic portion of the element, *viz.* :—

$$H_3 + H + H_3 + H$$

so it is possible that scientists may trust the statement that when an opportunity occurs of demonstrating the structures of the remaining three elements in the Table, the 5.02 will be shown to be due to the same cause.

Table XVII gives the cases in which two similar elements differ in volume by 5.02 or 2(5.02) at 15° C.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

19,496.—Las Heras A. de.—Combined developing and fixing medium for photographs. August 6th.

19,812, 19,313.—Lever Bros., Ltd., and MacLennan, K.—Treatment of oils and fats. August 4th.

19,391.—Nouvelle, A. — Production of hydrogen. August 5th.

19,565.—Soc. of Chemical Industry in Basle.—Manufacture of dyestuffs. August 7th.

19,303.—Still, C. (Firm of).—Eliminating sulphuretted hydrogen from gases. August 4th.

Specifications Published.

255,923.—Simon, L. J., Simon, A., and Simon Bros. (Engineers) Ltd.—Method of and apparatus for the extraction of oils, fats, waxes, greases, and the like from material containing the same.

255,925.—Schestakoff, P., & Merejkovsky, B.—Preparation of photographic developers.

255,963.—Synthetic Ammonia & Nitrates, Ltd., and Humphrey, H. A.—Carrying out exothermic gaseous catalytic reactions.

255,971.—Abbott Laboratories. — Process for making arsophenyl amino alcohols.

256,068.—Dodd, H., Sprent, Dr. W. C., and United Alkali Co., Ltd.—Manufacture and production of hydroxy-chloranthraquinone.

Printed Copies of the full Published Specification may be obtained from the Patent Office, 25 ,Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

HIGHTREE.

468,867. Unguents and balsams, being chemical substances prepared for use in medicine and pharmacy.—Jan Hoogenboom, 62a, Stationsweg, Rotterdam, Holland. August 11th.

RAMAK.

469,976.—Chemical substances prepared for use in medicine and pharmacy.—Charles Ramage, 119, Arisaig Drive, Mosspark, Glasgow. August 11th.

ANZYPAN BRAND.

470,127.—Chemical substances prepared for use in medicine and pharmacy.—H. R. Napp, Ltd., 3 and 4, Clement's Inn, Kingsway, London, W.C.2. August 11th.

IOSALT.

470,487.—Chemical substances prepared for use in medicine and pharmacy.—H. F. Cabell, 303, Wimbledon Park Road, London, S.W.9. August 11th.

UNIVERSITY OF MANCHESTER.

CHEMISTRY COURSES.

A Prospectus containing full particulars of the Lectures and Laboratory Courses qualifying for Degrees in Chemistry will be forwarded on application to the Registrar.
The Session commences on October 7th. Applications for admission to the Research Laboratories should be made to the Director of the Chemical Laboratories.

FULL-TIME TEACHERS Required in the PHYSICS and the CHEMISTRY Departments of the Northern Polytechnic. Good Degree essential. Salary, Burnham scale according to qualifications and experience. Applications to be received by the 6th September. Forms to be obtained from the Clerk to the Governors, Northern Polytechnic, Holloway, London, E.7.

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MODIFICATION OF BAEYER'S STRAIN THEORY. PART 1.

By W. F. SHORT.
(University College, Auckland, New Zealand.)

Much of the criticism which has, from time to time been directed against Baeyer's strain theory is invalid when it is recalled that Baeyer applied the theory to the unsubstituted polymethylenes and says in his original paper[1] "Von de Hereinziehung des Thiophens, der Lactone u.s.w. in diese Betrachtungen sehe ich absichtlich ab, weil dabei die Gegenwart andere Elemente zu berücksichtigen ist." It is therefore not to be expected that the original theory will explain, without some modification, phenomena connected with substituted polymethylenes, particularly when the substituents are strongly polar in nature. On the other hand, numerous legitimate exceptions and contradictions to the theory have been recorded. These especially concern the *cyclopropane* and *cyclobutane* rings and rings containing more than five members. Sachse[2] suggested that strain may be eliminated from a six-membered ring if the nuclear carbon atoms are no longer uniplanar, and there is now evidence which supports Sachse's hypothesis and renders it probable that higher ring systems are similarly constructed ([2 4 5 6 7]).

In this paper it is proposed to examine the two chief modifications of Baeyer's theory and to give some account of the factors which influence the ease of formation and stability of ring systems containing not more than five nuclear carbon atoms.

1.

INGOLD'S MODIFICATION OF THE STRAIN THEORY.

Ingold[8] has pointed out that the quantities of heat absorbed in the process of ring formation calculated by Stohmann and Kleber[9] from the heats of combustion of various derivatives of the cycloparaffins and those of the corresponding paraffin compounds, are not in strict agreement with the strain theory. For example, more heat is absorbed in the formation of the cyclobutane ring than in that of the cyclopropane ring than in that of the cyclopropane ring which is more strained ((b) Table I). This comparison is, however, not valid since the thermal values concern the *total* strain in the cycloparaffin rings, whereas the Baeyer strain angle considers the deflection of the valencies from the normal in the case of *each* carbon atom in the ring. To obtain a legitimate comparison, the thermal values must be divided by the number of carbon atoms in the ring. When this is done it is found that the energy contents of the cyclopropane and cyclobutane rings are in agreement with the Baeyer strain angles ((c) Table I.). Moreover, Hückel[10] has calculated (from the heats of combustion of the cycloparaffins themselves) the excess heat evolved by the combustion of a ring methylene group compared with that evolved in the combustion of an open chain

* An abstract of this paper was read at a meeting of the Auckland Institute on July 6, 1926.

methylene group. His results, derived from more reliable data than Stohmann and Kleber's and based upon a more direct comparison, are shown in Table I(d), and agree qualitatively with the strain angles. The majority of fission experiments indicate that the cyclopropane ring is more easily opened than the cyclobutane ring, which is again in agreement with the strain theory.

TABLE I.

	Cyclopropane	Cyclobutane	Cyclopentane
(a) Angle of Strain	24.7° ...	9.7° ...	0.7°
(b) Heat absorbed (cals.)	37.1 ...	39.9 ...	16.1
(c) Heat absorbed per carbon atom ...	12.4 ...	10.0 ...	3.3
(d) Excess heat of combustion of ring methylene group	10.5 ...	7.5 ...	1

Turning now to methods of ring closure we find, as Ingold has pointed out (*loc. cit.*) that methods of preparation of five-, six- and even three-carbon rings fail, either wholly or partly, when applied to the production of cyclobutane rings. This indicates that although Baeyer's theory is in accord with the relative stabilities of at least the unsubstituted polymethylenes (below cyclohexane), it fails to agree with their relative ease of formation. Ingold has suggested (*loc. cit.*) that the divergence between the theory and the experimental observations may be due to the possibility of the calculated angles being incorrect through modification of the normal tetrahedral angle of Baeyer, 109.5°, due to the volume of the four attached atoms or groups. He assumes that the tetrahedron representing a carbon atom is approximately regular only when the carbon atom is attached to four atoms of the same volume, and points out that if any methylene carbon atom in a paraffin be considered, the angle between the carbon-to-carbon valencies will be greater than that between the carbon-to-hydrogen valencies, since the volume of each of the attached hydrogen atoms is much less than that of each of the two attached carbon atoms. Ingold deduces that the angle (2θ) between the carbon-to-carbon valencies is given by

$$\text{Cosec}\ \theta = 1 + \frac{h}{a + b + \sqrt{6ab}}$$

where a is the atomic radius of carbon and b the atomic radius of hydrogen; a and b being proportional to the cube roots of the atomic volumes. [The complicated expression given by Ingold (*loc. cit.* p. 307) requires correction. The last term in the denominator should be squared and the fraction then reduces to the simplified form given above.] In order to arrive at this expression the spheres representing the hydrogen and carbon atoms (attached to the central carbon atom) are assumed to be in mutual contact. This assumption involves the conclusion that the volume of central carbon atom must be very much less than that of each of the attached carbon atoms. Since, however, all the carbon atoms are equivalent, each occupies the same volume and the assumption made is therefore invalid. If the assumption be made that the directions of the valencies arrived at by the above reasoning remain unaltered while the domain of the central carbon atom increases to the same size as that of the attached carbon atoms, the latter are no longer in contact, and the deduced expression is no longer tenable.

There appears, however, to he considerable justification for the view that the volumes of the atoms attached to a carbon atom play an important part in determining the directions of the valencies of the carbon atom. Although Ingold's method of attack does not appear to be justifiable, the problem may be attacked in another manner, which is more in keeping with the method adopted by Thorpe and his co-workers[11] for deducing the angle between the extra-nuclear valencies of a spiro carbon atom. The assumption is made that the angular space *between* the domains of each pair of attached atoms subtended at the centre of the central atom is the same. In the case of the paraffin methylene group the arrangement is as follows :—

Two spheres of radius a (representing the carbon atoms) and two of radius b (hydrogen atoms) are arranged in external contact with a sphere of radius a and centre O (central carbon atom) in such a way that the inner tangents from O to each pair of adjacent spheres in the plane through their centres make equal angles (2t). It can

then be shown that

$$\cos(\alpha + \beta + 2t) = -\tfrac{1}{3}\cos(\alpha - \beta) \qquad \text{(A)}$$

where $\alpha(=30°)$ and β are the angles subtended at O by the radii of the spheres of radius a and b, $\sin\beta = \dfrac{b}{a+b}$ and $2\theta = \alpha + \beta + 2t$ = angle between the carbon-to-carbon valencies.

The angle between the carbon-to-carbon valencies of the central carbon atom in the group

C-CH(C)(C)

is given by the approximate solution of the equation

$$\sin(\alpha + t) = \sin 60° \sin(\alpha + \beta + 2t) \qquad \text{(B)}$$

In order to arrive at the domains of the various atoms Ingold made use of Traube's determinations of the atomic volumes of carbon (9.9 and hydrogen (3.1). These values are now regarded as incorrect [12 13]. Instead of using particular values of the atomic volumes it is preferable to make nse of the well-established ratio (4 : 1) between the atomic volumes of carbon and hydrogen, determined from a very large number of compounds [14].

In Table II. the results obtained by the above method are compared witb those obtained by Ingold.

TABLE II.

Angle between C-to-C valencies in	Ingold's method (Traube's Atomic Volumes).	Tangent method (Le Bas' Atomic Volnmes).
C, C >C< H, H	115.3°	116.6°
C, C >C< C, H	112.5°	113.0°

Although the angles calculated by the different methods are approximately the same, the difference between the two arrangements is shown by the fact that, in the case of the methylene group, the tangent angles are all 56.6° in the second arrangement, whereas in Ingold's arrangement they are 0° and 3.57° when the central carbon atom is small or interpenetrating, and 23.8°, 15.4° and 42.8° when the central carbon atom has its normal volume.

The angles of strain in the cycloparaffins may now be calculated using the alternative values (115.3° and 116.6°) for the normal angle between the carbon valencies.

TABLE III.

Normal Angle	115.3°	116.6°
Cyclopropane ...	26.6 ...	28.3
Cyclobutane ...	12.6 ...	13.3
Cyclopentane ...	3.6 ...	4.3

It is significant that Ingold's strain angles do not show tbe maximum strain in the cyclobutane ring which he anticipated, and it is probably for this reason that he has preferred to *calculate* "by *how much*" the terminal atoms in n-propane, n-butane, etc., must approach one another in forming a cyclopropane, cyclobutane, etc., ring. It should be noted however, that the approach values (Table IV.) calculated from Baeyer's angle also show a maximum at cyclobutane.

TABLE IV.

Normal Angle ...	109.5°	115.3°	116.6°
Cyclopropane ...	0.316	0.345	0.350
Cyclobutane ...	0.333	0.427	0.441
Cyclopentane ...	0.044	0.220	0.256

The results are in agreement with the relative ease of formation of the cyclopropane and cyclobutane rings, but do not agree with their relative stabilities. It is probable that the "approach values" are an expression of one of the factors which inflnence the ease of formation of carbon rings.

It is obvions that the presence of a gem *dimethyl group will facilitate the formation* of those rings which are produced by an inward deflection of the normal angle of the carbon valencies, since the amount of approach of the terminal carbon atoms necessary for ring formation will be diminished. The stability of these ring systems containing a gem dimethyl group should also be increased. Kötz[15], however, claims that the stability of the trimethylene ring is decreased by the introduction of alkyl groups so that, for example, 1 : 1 dimethylcyclopropane is less stable that methylcyclopropane. It is therefore clear that the "volume factor" is not always the only one which influences ring stability. Ingold (*loc. cit.* and snbsequent papers), has advanced a considerable amount of evidence in favour of his hypothesis and although it is impossible here to examine the vast amount of experimental results

which he has obtained, a few points may be dealt with.

Ingold has examined the elimination of bromine from α bromo dibasic esters, C_2H_5 OOC.CHR $(CH_2)_n$ CR'(Br) $COOC_2H_5$ under two sets of standard conditions (a) using dilute aqueous sodium carbonate (b) using strong methyl alcoholic potassium hydroxide. *The main reaction in the first* case is the replacement of bromine by hydroxyl, while in the second case a small amount of unsaturated acid is produced, but the main products are the hydroxy acid, and the ring acid, one of which may predominate. By comparing the relative amounts of the hydroxy acid and the ring acid produced, it is claimed that non-steric factors affecting ring formation are eliminated to a large extent, since it is reasonable to suppose that changes in the reactivity of the bromine atom would be approximately equally effective in retarding or stimulating the formation of both these reaction products. The results so obtained are summarised in Table V.

TABLE V.

Ring acid derived from	No. of parts of ring acid formed for every part of hydroxy-acid.
Cyclopropane	3
Methylcyclopropane ...	1.33
Cyclobutane	0.002

They appear at first sight to favour Ingold's hypothesis, but it is necessary to examine the assumptions involved more fully. It does not necessarily follow that alteration in the reactivity of the bromine atom will influence the formation of the hydroxy-acid and the ring acid to an approximately equal extent, because the activity of the hydrogen atom eliminated in ring formation is also an important factor. An instance in which this factor is operative and which illustrates the insufficiency of the "volume factor" to account for the whole of the phenomena encountered is to be found in the behaviour of the bromo-α methyl glutaric esters. Ingold[16] remarks that it is curious that when the isomeric mono-bromination products of α-methyl-glutaric ester are treated with dilute alkali, they are converted into the hydroxy-acids quantitatively, whereas α-bromoglutaric ester, under the same standard conditions, gives rise to a small quantity of the ring acid as by-product. This is held to be the more remarkable when count is taken of the lability which tertiary hydrogen usually displays as compared with secondary hydrogen in an otherwise similar situation, examples of which are given. Now, if we exclude steric hindrance as a factor influencing the chemical reactivity of an atom, the relative activity of an atom (in the same or different compounds) *in the same type of reaction* will depend upon the alternate and general polar influences exercised upon it by the other atoms in the compound. (Lapworth[17], Robinson [18, 19].) It is therefore clear that a tertiary hydrogen atom may be more or less "reactive" than a secondary hydrogen atom according to the nature of such influences. In the examples quoted by Ingold the tertiary hydrogen atoms are under polar influences which render them more "reactive" than the secondary hydrogen atoms. In view of the fact that Ingold himself had shown that α-methyl glutaric chloride yields on bromination the γ-bromo derivative almost exclusively, the isomeric α-bromo compound being formed in very small amount, it is not surprising that the tertiary hydrogen atom which is replaced by bromine with such difficulty also shows a reluctance to unite with bromine and produce the ring acid.

The results of a brilliant series o finvestigations by Thorpe, Ingold and their co-workers[20], which led to the discovery of ring-chain tautomerism, seem to indicate that a larger deflection of the "methylene" carbon valency angle is produced by the gem-diethyl, gem-dipropyl and similar groups than by the bem-dimethyl group, and at the same time constitute the most weighty evidence for the "volume effect" that has so far been brought forward. It is difficult to see how the values of the deflected angles could be calculated by the method adopted by Ingold for the calculation of the "methylene" carbon valency angle. The "tangent method," however, should allow these angles to be calculated to a first approximation.

II.

RUZICKA'S MODIFICATION OF THE BAEYER STRAIN THEORY.

During the preparation of this paper for publication the author received the current number of the *Helvitica Chimica Acta*, containing a paper on the Baeyer strain theory by Ruzicka and his co-workers[7]. Some of

the conclusions arrived at by these authors are identical with those here recorded.

Ruzicka considers that the relative ease of formation of carbon rings containing up to ten atoms is governed by two factors (a) the ease of formation of an intramolecular C-to-C bond (main factor), and (b) the strain in the ring compound formed (subsidiary factor). The ease with which an intramolecular carbon-to-carbon bond is formed is assumed to decrease continuously with increasing separation in the chain of the carbon atoms concerned. The ring strain decreases from dimethylene to pentamethylene and then remains approximately constant. The result of these two factors is to produce a large decrease in ease of formation in passing from dimethylene to trimethylene and a sharp rise in passing from tetramethylene to pentamethylene.

The factor (a) is a measure of the influence of the *starting materials upon the ease of* ring formation, and, so far as it goes, is a recognition of a general polar effect. It cannot be claimed, however, that the reactivity will always fall off continuously *as the length of the chain is increased. This* was recognised many years ago by Michael[21] and at the present time it is still uncertain whether part of the general polar effect may not be transmitted directly through space and so produce an irregular increase (or decrease) in activity in certain cases. (Compare Lewis[22].) The presence of strongly polar groups (Lapworth and Robinson, *loc. cit.*) will also render Ruzicka's assumption untenable in many cases, for, although such effects are not transmitted through a chain of more than two saturated carbon atoms, a hydrogen atom at one end of the chain may be "activated" by a neighbouring polar group and will then be more likely to be eliminated with a bromine atom (at the other end of the chain) than will a hydrogen atom nearer the bromine atom but in a less "activated" condition.

Experimental results obtained by Ingold[8] show that Ruzicka's assertion that a double bond is more easily formed than any other ring system is not valid in all cases. Thus, by the action of alcoholic potash upon ethyl α-bromoglutarate results in the formation of 16% of α-hydroxyglutaric acid, 47% of cyclopropane dicarboxylic acid and only 3% of glutaconic acid. That is, in spite of the considerable steric hindrance to be overcome in the formation of the cyclopropane ring, the unsaturated acid is produced in very much smaller amounts than the ring acid.

III.

General Conclusions.

(a) It is probable that carbon rings containing more than five members are multiplanar and are therefore free from strain in the Baeyer sense. (Compare Ruzicka, *loc. cit.*)

(b) The relative ease of formation of carbon rings is not directly proportional to their relative stabilities. Thus, the cyclobutane ring is more stable than the cyclopropane ring, but the latter is frequently more easily formed.

(c) The main factors which control the relative ease of formation of carbon-rings are (i) the "activities" of the atoms eliminated (in ring formation) as influenced by *general and alternating polar effects* produced by polar atoms; (ii) the *spatial* proximity of the polar atoms eliminated in ring formation. In cases where the production and fission of the ring is reversible *under the conditions of the synthesis*, the strain in the ring would obviously exert a modifying influence. The most satisfactory measure of factor (ii) is afforded by the "approach values" calculated by employing the value of the "normal" angle deduced by the tangent method.

In some cases factor (i) will exert a predominating influence and in others factor (ii) will be the more powerful. In no case, however, may factor (i) be entirely disregarded. (This point will be discussed in a subsequent paper.)

(d) The stability of a carbon ring system is measured approximately by the angle of strain and, except in extreme cases where strongly polar groups are present, polar conditions in the ring will not exert a powerful influence on the relative ease of ring fission.

The equations (A) and (B), for the "tangent arrangement" were deduced by Professor D. M. Y. Sommerville, of Victoria College, Wellington. The author's thanks are due to him both for these equations and for checking other mathematical expressions used in the course of this investigation. My thanks are also due to Professor Worley for his interest in this work.

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THE ENERGY OF HIGH VELOCITY ELECTRONS.

By Marsh W. White.

Precision determination of the energy of high velocity electrons.—The *total heat generated in an x-ray tube* operated at potentials up to 25,000 volts was measured by immersing a Coolidge x-ray tube of the water-cooled type in an oil bath and noting the temperature rise of the oil for a precisely measured energy input. The current and voltage furnished to the tube by a high potential d.c. source were kept constant and were continuously measured by potentiometers. The heat energy given up to the oil by this "high potential" source was compared with that developed by the same quantity of "low potential" energy by taking alternate runs wherein the same potentiometers measured the current and voltage supplied from a storage battery to a heating coil immersed in the oil. The data proved with a probable error of about 0.2 per cent., that, up to 25,000 volts, all of the energy input into a Coolidge tube is ultimately transformed into heat and that any sources or sinks of energy which may exist have a smaller effect than 0.2 per cent. Ionisation, photographic and pyrometric methods were used to test for the presence of radiations involving an *absorption of energy at the cathode.* No appreciable quantity of such energy could be detected. The results of these experiments indicate that all of the input energy must go into the energy of the moving electrons and their fields. It also follows that only a negligible portion of the current in a Coolidge tube is furnished by positive ions which actually reach the cathode, for otherwise the cathode would be heated.

These experiments indicate that all of the energy input into an x-ray tube goes into the moving electrons and their fields. Furthermore, it is shown that, within 0.2 per cent. or less, this energy is as completely given up when the electrons are arrested, *i.e.*, that $Vit = JH$ for electrons moving with velocities up to 25,000 equivalent volts. This shows, within the limits mentioned, that there are no atomic molecular changes involving a source or sink of energy in a Coolidge tube at 25 kv. It also follows that only a negligible part of the current in a Coolidge tube is furnished by positive ions reaching the cathode, for otherwise the cathode would be heated a measurable amount. The heat received at the target of a water-cooled Coolidge tube may be only from 75 to 97 per cent. of the total energy input, the remainder of the energy being dissipated at the walls of the tube as a result of their bombardment by "reflected" electrons.—*Extract from the "Physical Review."*

OBITUARY.

Dr. J. G. Adami.

We regret to record the death, which took place on August 29, of Dr. J. G. Adami, Vice-Chancellor of the University of Liverpool.

British Association for the Advancement of Science.

SECTION K.—BOTANY.
1860—1894—1926.

ADDRESS BY PROFESSOR F. O. BOWER, Sc.D., D.Sc., LL.D., F.R.S.
PRESIDENT OF THE SECTION.

"*The future of Biology lies not in generalisation, but in closer and closer analysis.*"—Bateson (Birkbeck Lecture, 1924).

Death, sudden and wholly unforeseen, has stepped between this Section and the President of its choice. Professor Bateson had presided over the whole Association at its meeting in Australia, and partly on that account he had been selected for the chair of this Section in Oxford. From him we might have expected a broad outlook upon biological science. His address would have been instinct with wide experience in both of the branches of living things, the interests of which interweave in enthralling and often most perplexing ways. We should have heard a fearless statement of his mature views. Something constructive would certainly have justified the congratulations with which some of us had already welcomed his nomination. A great figure has been taken from the arena of biological science. A career still full of promise of further achievement has closed prematurely.

1860.

I need not remind you of the fact that the meeting in Oxford of 1860, the year after the publication of the 'Origin of Species,' witnessed the clash between the new view and the opposition it was certain to arouse. The story has been often told of the aggresive attack and the crushing retort. But it is not sufficiently recognised that, though Huxley bore the first brunt of the fight, a large part in the contest was taken by Hooker. The meeting closed after he had spoken, and in his own words he was 'congratulated and thanked by the blackest coats and the whitest socks in Oxford.'

Two generations have passed since the Oxford meeting of 1860; and still the 'Origin of Species' holds its place as a great philosophical pronouncement. As the methods of research passed into greater detail, the area of fact has been extended through the labours of an ever-growing army of inquirers, and naturally divergences of view have arisen. Some authors appear to demand that for all time the 'Origin' must cover every new aspect of biological inquiry, or else the whole theory crumbles. That is to demand a prophetic vision for its author. We need not for the moment follow these or other criticisms, but rather recognise that the theory rested essentially on facts of heritable variation, without defining their magnitude, limitations, or origin; and that it explained a means of their summation so as to produce progressive morphological results. As an index of current opinion on the validity of Darwin's theory as a whole, I would draw your attention to three British works on evolution, all published within the last two years. In 1924 Dr. Scott concludes his volume on 'Extinct Plants and Problems of Evolution' with the judicious sentence: 'I may venture . . . to maintain that a consideration of all the evidence . . . is on the whole favourable to the old, truly Darwinian conception of an orderly and gradual evolution without sudden and explicable leaps, an evolution in harmony with the uniformitarian principles established by Lyell.' But he remarks that he does not favour any exaggerated ideas such as the so-called 'omnipotence of natural selection.'

In the present year Professor Graham Kerr ,in his volume on 'Evolution,' also adopts a distinctly Darwinion position, but with greater stress laid upon the potency of natural selection; this might be expected from one who spent some of his most im pressionable years in the wild surroundings of the Gran Chaco. He speaks from experience of the effect of selection as being 'in actual fact enormous,' and he holds that the attempts that have been made to minimise its importance are to a great extent fallacious. He sees in the recognition of the

Mendelian inheritance that the natural selection has been greatly fortified since Darwin's day. Variability, upon which the *theory* depends, he regards as an expression of that instability which constitutes one of the inherent and most characteristic features of living substance, and he states that such variation has to be accepted as a basic fact. He further regards as an added strength to the Darwinian theory 'the recognition that a particular variation is the outward expression of a *tendency* to vary in that particular direction, and that as a consequence the selection of variations in a particular direction involves a necessary intensifying of the tendency towards that particular variation, and in turn the encouragement of evolutionary progress along a definite directed line.' These expressions are in general accord with the doctrine of Weismann that acquired characters, or, as Graham Kerr terms them, 'impressed' characters, are not themselves inherited. It is not for a botanist to interfere with the arguments of zoologists on this question, as applied in their own science. There are, however, zoologists who strongly maintain their belief in such inheritance, a position upheld by Professor MacBride in the volume on 'Evolution' published last year by Messrs. Blackie, which is the third of the works above mentioned.

In that same volume I took the opportunity of stating that the question of the origin of heritable characters, or mutations as they are called, is still quite an open one for plants. But it was maintained that a wide latitude of time is a real factor in the problem. This was already recognised by Hofmeister, who on the last page of his 'Allgemeine Morphologie' said : 'It appears to me probably that only gradually, in the course of many years' development, the influential effects on outer form appeared and became hereditary.' Thus Hofmeister contemplated a slow inheritance of acquired or impressed characters in plants. To anyone who notes how directly susceptible individual plants are to external conditions, and how greatly these affect their individual form, it would seem improbable that there should be any sharp line of demarcation between the individual and the racial life, or that what acects every individual plant so profoundly should never affect the race. In my essay in Messrs. Blackie's volume on 'Evolution,' I advanced comparative evidence, which commends itself to my own mind as a morphologist, indicating that the boundary between fluctuating variations and heritable mutations is not absolute; in fact that in plants, given latitude of time, variations related casually with with external circumstance, and not merely initiated at random, are liable to be transmitted to the offspring. There is no need to repeat the argument here, for it was submitted to the Section at Southampton. It may be remarked that this is in direct opposition to the doctrine which Weismann laid down with special reference to the animal kingdom. But what may be applicable for one kingdom of living things does not necessarily apply for the other. The evolution of animals and plants has certainly been homoplastic in all its later stages. Our minds should be perfectly free to follow the facts of our own science to their legitimate conclusions. These indicate to me that heritable variations in plants have been promoted or actually determined in their direction, or their number, or their quality, in some way by external conditions. But these need not necessarily have worked within restricted time-limits of present experiment; for the wide latitude of geological time has been available for evolution to proceed. Hence negative results of the experiments of a few years need not be held as overruling the conclusions drawn from comparison of nearly allied forms.

Before we leave this historical aspect of evolution a moral may be drawn from the lives of its four protagonists of 1860. Darwin, Wallace, Hooker, and Huxley were all equipped for the battle from the armoury of personal experience in the great world. The theory of evolution was born and bred of foreign travel, and upon foreign travel quite as much as upon quiet work at home its future still depends. We should not for a moment minimise the great developments of laboratory study and of breeding experiment in recent years that bear upon its progress. But it is not thence alone that the fullest achievement can be anticipated. The cytologist and the breeder, just as much as the abstract theorist, should know Nature face to face, not merely through a glass darkly. To those who believe in the close relation between environment and variation, which is to me the very core of evolution, this seems essential to any well-balanced view. The open forest, the sea-coast, steppe, and mountain-side should be regarded as the natural complement to the laboratory and the breeding-station. No one, morphologist or physiologist, should

hold himself equipped for research or fully qualified to teach unless he have at least some experience of travel through wild Nature. This can best be acquired in the tropics. But what do we find?

In 1886 a committee of this Association was appointed to assist the visits of botanists to Ceylon for study. Several well-known botanists availed themselves of its aid; but after a few years the scheme flickered out through inanition. In 1909 I visited the Cinchona Station in Jamaica, and again a scheme for continued use of the station by British botanists was initiated; but it has since died out for want of consistent support. Why did these efforts fail? We may set these failures down to under-valuation of the importance of foreign, and particularly of tropical, study; and the lack of full perception that open Nature is the greatest laboratory of all. Our future Botany seems in danger of becoming myopic by reason of study being concentrated at too short focus. To correct this, young aspirants should travel early, as free lances, hazarding the fortune of the young wild, as Darwin and his fellows did.

HOMOPLASY.

I have already alluded to the tempestuous meeting of 1860 in Oxford. Shortly after it an undergraduate came up to Christ Church who, before he was of standing to take his M.A. degree, had himself made a real contribution to the philosophy of evolution. It was Ray Lankester, who in 1870 published a short paper ' On the nse of the term Homology in Modern Zoology, and the distinction between Homogenetic and Homoplastic Agreements." Its author was only twenty-three years of age, and its date barely a decade after the publication of the ' Origin.' This short paper went far to clear up the vague ideas surrounding the term ' homology ' in the minds of early evolutionists. Lankester introduced the idea of ' homogeny,' substituting in a more strict sense the word ' homogen ' for ' homologue.' He also suggested, to avoid confusion, the use of another new terms, *viz.*, ' homoplasy.' He defined homogeny as simply the inheritance of a common part, while homoplasy depends upon the common action of evoking causes or of a moulding environment upon homogeneous parts, *or* upon parts which for other reasons offer a likeness of material to begin with.

This definition was at once adopted in the morphological study of animals, but Lankester did not himself apply it at the time to the morphology of plants. In point of fact the conception of homoplasy and the use of this clarifying term made its way but slowly into botanical literature. There is reason to believe that we are as yet only beginning to recognise in the evolution of the plastic plant-body how far-reaching has been the influence of homoplasy ,not only upon external form, but also in the internal evolution of tissues. As to external form, a wide recognition of the results of homoplasy is now generally accepted for land-living plants, and in particular in respect of the origin of foliar appendages; for instance, the leaves in Bryophytes and Vascular Plants are held as homoplastic, not as homogenetic; similarly with the leaves of Bryophytes, and possibly also of Pteridophytes, *inter se*. On the other hand, we may find among the larger Brown Algæ indications of the differentiation of a supporting organ and lateral appendages from a common branch-system, that can only have been homoplastic with an origin of like parts in certain Red Algæ. Such conclusions, drawn from the Algæ themselves as well as from the Archegoniatæ, have the natural effect of raising distrust of wide comparisons between any seaweed and any land-plant in respect of foliar differentiation. Comparisons of this nature cannot be held acceptable as mere guesses, by loose reference between one class and another. They would have to be based on the recognition of compact sequences within reasonably close circles of affinity before they could carry conviction.

Similarly in the morphology of the internal tissue-tracts, we are already familiar with certain exmaples of homoplasy; for instance, that of secondary thickening. No one would now hold, with the school of Brongniart, that all plants with cambial activity are akin. Bnt it is only in later years that we have come to realise the far-reaching results of homoplasy in the region of primary vascular morphology. Medullation, solenostely, polycycly, and dictyostely have all arisen in more than one phyletic sequence, while the fluted form of the stele, or of the xylem-tract that it contains (which gives a stellate transverse section), is now recognised as a conformation meeting the demands that follow from increasing size, rather than as an indication of community of racial origin. These are examples of the effect of internal homoplasy. We are only now beginning to realise how far-reaching have been its results in plants as we see

them. On the other hand, such realisation when well assured cannot fail to react upon our estimates of affinity of the organisms in which homoplasy appears. It may be going too far to trace all such results as consequences of the meeting of 1860; but the initiative was certainly given by Lankester in the years that followed.

1894.

Passing from the stormy period of 1860, when the whole outlook of biological science was being transformed by the advent of evolution, to 1894, we see that the atmosphere had cleared. One result was that the evidence of descent tended to become too definite in the minds of some enthusiasts, and there was even a disposition to argue deductively from the accepted position, a tendency that is much too prevalent to-day. I feel bound to refer critically to my own contribution to that meeting, which was the statement of a Theory of the Strobilus. Thirty years have materially extended the field of established fact. Though certain parts of that theory relating to sterilisation may still hold, in view of new and material facts, any close comparison between a vascular strobilus as a whole and a bryophytic sporogonial head must fall. In particular, the suggestons of progressive septation and eruption of appendicular organs cannot now be upheld as accounting for the origin of a compact strobilus. The theory was stated tentatively, as a working hypothesis, and time has shown that the hypothesis does not accord with facts now known.

The outstanding feature of the Oxford meeting of 1894 was Strasburger's generalisation on the Periodic Reduction of Chromosomes. This shed a new light on the vexed question of alternation which, based on the brilliant results of Hofmeister, by this time held the field not only as an objective but as an evolutionary problem. The effect of Strasburger's communication was to establish the chromosome-cycle as general for plants that show sexuality. It provoked comparison with a similar cycle in animals. The recognition of both cycles took its origin in the discovery by van Beneden in 1883 that in sexual fusion the number of chromosomes is the same in both of the conjugating nuclei. Later observers have confirmed this in a multitude of instances, and disclosed the correlative reduction, or meisosis. The existence of a nuclear cycle alike in animals and in plants cannot, however, be held as establishing any homogenetic unity of the two kingdoms. Comparison of the simpler forms of each indicates that the divergence of the kingdoms, if ever they had a common origin, was very early indeed, and probably antedated sexuality in either. Such similarities as they show in propagative detail, and particularly in the nuclear cycle, would be homoplastic, not homogenetic. If this be so for the two kingdoms of living things, may it not be equally true for the several phyla of plants that show sexuality; for we are not justified in assuming that sexuality arose but once in plants?

Historically this generalisation of Strasburger fell like a bomb-shell into the midst of the old controversy between the rival theories of alternation, styled in the words of Celakovsky 'homologous' and 'antithetic.' But it must be remembered that at the moment there was no complete demonstration of a cytological alternation in any one Alga, though the facts soon followed for *Fucus* [Strasburger (1897), and Farmer and Williams (1898)]; and for *Dictyota* (Lloyd-Williams ,1897-8). We need no recite again the arguments *pro* and *con* of that old discussion. It soon lost its intensity in face of the obvious deficiency of crucial facts, which alone could lead to some final conclusion. Loose comparisons between organisms not closely allied are but the long-range artillery of morphology. Comparisons between organisms closely related are its small arms. The discussions of the 'nineties of last century on alternation were all engagements at long range, which could not be decisive without the use of close comparison. As the necessary facts were not then in our hands, those premature engagements might be held as drawn; and it was open to both parties still to entertain their owu opinions. Meanwhile it may interest us as spectators to note the relation that exists between homoplasy as defined by Lankester in 1870, and those intimate questions that arise from Strasburger's paper to this Section in 1894. The cytological facts acquired since the latter date tend to confirm the normal constancy of a nuclear cycle. Their effect has been to accentuate more than before the inconstancy of the somatic developments related to it. Like the fabulous genie let loose from its bottle, the conception of a nuclear cycle in plants that show sexuality, disclosed in 1894 by Strasburger, dominates ever more and more the morphological field.

Before discussing the relation of somatic

development to that cycle, it will be well to revise the terminology. The word 'homologous' has a double significance, as shown by Lankester. If it be used to include examples of 'homoplasy' the whole field is open for what has been styled antithetic alternation, in which the two generations were presumed to be homoplastic. If in the sense of 'homogeny,' then it would be necessary to prove the relation of the somata throughout descent to the nuclear cycle. On the other hand, the term 'antithetic,' while it accentuates the difference between the two somatic phases, is not explicit, in that it does not describe the method believed to have been involved in their origin. It would be well to drop these old terms, which are neither exact nor explicit, and to support a more general use of the words '*interpolation theory*' in place of 'antithetic,' and '*transformation theory*' in place of 'homologous.' These words accord better with current views, and are explicit.

(*To be Continued.*)

General Notes.

SECOND EMPIRE MINING AND METALLURGICAL CONGRESS,

CANADA, AUGUST-SEPTEMBER, 1927.

We are advised by the Hon. Secretary-General, Mr. C. McDermid, as follows :—

As announced in February last, the Empire Council of Mining and Metallurgical Institutions on behalf of the ten Constituent Bodies, accepted a cordial invitation through the Canadian Institute of Mining and Metallurgy, to hold the second (triennial) Empire Mining and Metallurgical Congress in Canada in August-September, 1927.

An influential Organising Committee representative of the whole of the Dominion has been constitnted, and an exceptionally attractive programme is now practically completed. It embraces Sessions in Montreal (inaugural), Toronto, Winnipeg, and Vancouver, with visits to mines and works and places of scenic beauty throughout the Dominion. The full programme will occupy about six weeks in Canada.

The Organising Committee have secured the full approval of the Congress by the Dominion and Provincial Governments, and the Minister of Mines has emphasised the direct interest and support of the Dominion Government, by accepting an invitation to act as President of the Congress.

Offers of generous hospitality have been received by the Organising Committee from Municipal Authorities, and others in all parts of the Dominion, whilst excellent travelling facilities and concessions have been offered by Shipping Companies and Railway Authorities.

The fullest information will be embodied in a comprehensive series of communications to be issued to members of the Constituent Bodies by the Organising Committee, through Mr. George C. Mackenzie (Secretary of the Canadian Institute of Mining and Metallurgy), the General Secretary of the Congress, whose address is Drummond Building, Montreal, Canada.

I am desired to express the hope of the Empire Council and the Organising Committee that members of the Constituent Institutions will themselves make every effort to take advantage of this exceptional opportunity of inspecting the mines and works of the Dominion and of seeing Canada under such favourable conditions, and also bring the Congress to the notice of other interested persons.

MANUFACTURE OF ASBESTOS AND ALLIED PRODUCTS IN CANADA, 1925.

Manufactures of asbestos and allied products in Canada amounted to $1,344,097 according to a statement just issued by the Dominion Bureau of Statistics at Ottawa. This figure represents an increase of 128 per cent. over 1924, due largely to returns received from plants in Quebec.

Twelve plants reported to the Bureau in 1925 as compared with 9 in 1924. These plants represented a capital investment of 2.6 million dollars, gave employment to 256 persons, to whom $282,382 was paid in salaries and wages, and used $783,063 worth of raw materials in the manufacture of finished commodities for sale. There were 6 plants in Ontario, 4 in Quebec, 1 in Nova Scotia and 1 in British Columbia.

Products of this industry included magnesite stucco and flooring, and asbestos packing, brake linings, pipe covering, shingles and lumber.

Exports of asbestos from Canada in 1925 amounted in value to $9,737,964, of which only $55,572 was in the form of manufactures. Imports of asbestos products totalled $448,769.

COAL-DUST EXPLOSIONS.

In examining the problem of coal-dust explosions, the most important factors, with respect both to the ignition of coal dust and the propagation of flame in a dust cloud, are the degree of fineness, the shape and the distribution of the particles of dust in the cloud; and the particular physical quality involved in the specific surface of the dust, *i.e.*, the ratio of surface to mass in the particles of the dust.

The merits of the several methods which can be used for determining the specific surfaces of dusts are discussed in a paper by E. F. Greig entitled "Some problems connected with the determination of the fineness of coal dust" (Safety in Mines Research Board Paper No. 25, H.M. Stationery Office, Adastral House, Kingsway, London, price 1s. net).

As the result of the discussion it is concluded that sieving methods are not sufficiently accurate, that air elutriation methods provide means of obtaining grades of dusts of definite ranges of specific surface for the purpose of correlating specific surface and degree of inflammability of a dust cloud, that by a combination of elutriation, sedimentation and microscopic examination it is possible to grade the specific surfaces of dusts, and that other methods, of a more empirical nature, may be found useful for rapid determination and field use.

BOARD OF TRADE ANNOUNCEMENT.

NATIONAL FUEL AND POWER COMMITTEE.

We have been advised by the Board of Trade that in accordance with the recommendation of the Royal Commission on the Coal Industry for the establishment of a National Fuel and Power Committee, the President of the Board of Trade has appointed a standing Committee to consider and advise upon questions connected with the economic use of fuels and their conversion into various forms of energy, having regard to national and industrial requirements and in the light of technical developments.

The members of the Committee are:—The Rt. Hon. Sir Alfred Mond, Bart., P.C., M.P. (Chairman); Mr. J. Baker, M.P.; Mr. Mark Brand; Sir John Cadman, K.C.M.G., D.Sc., F.G.S., M.I.C.E.; Sir Arthur Duckham, K.C.B.; Sir William Hart, O.B.E.; Mr. Frank Hodges; Professor F. A. Lindemann, F.R.S.; Sir David R. Llewellyn, Bart.; Mr. M. Mannaberg; Mr. C. H. Merz, M.I.E.E., F.R.G.S.; Sir Alexander Walker, K.B.E.; Mr. D. Milne Watson, M.A., LL.B., D.L.

The Secretary of the Committee is Mr. W. Palmer, and the Assistant Secretary, Mr. R. J. Moffatt. All communications should be addressed to the Secretary, National Fuel and Power Committee, Board of Trade, Great George Street, London, S.W.1.

ESTABLISHMENT OF TECHNICAL AND OTHER COLLEGES AND SCHOOLS IN CHILE.

The British Consul-General at Valparaiso has forwarded an extract from *El Mercurio* of 28 May last summarising the terms of the will of the late Federico Santa Maria, a Chilean, who recently died leaving a fortune estimated at over 100 million pesos Chilean currency.

The executors and trustees have obtained legal authority to form a corporation, to be known as the Fundacion Federico Santa Maria, to carry out the objects of the trust in which the bulk of the property left has been vested.

By the terms of the will the money is to be devoted to:—

(*a*) The foundation of a School of Arts and Crafts to provide free accommodation for 350 pupils. The curriculum is to include mechanics, electricity, mining chemistry and building.

(*b*) The foundation of a College of Engineering to provide for 150 pupils at a time, the curriculum to comprise all branches of civil engineering.

(*c*) From a sum, equivalent to 10 per cent. of the income of the trust, to be set apart annually, funds are to be accumulated for the purpose of founding a commercial or industrial school every ten years in a town in Chile selected by the trustees; and scholarships are to be established to enable pupils of the College of Engineering to study in Europe or in the United States.

It is provided that for the first ten years the professional staff are to be without exception foreigners from Europe or the United States.

THE WOOD DISTILLATION AND WOOD EXTRACTS INDUSTRY IN CANADA, 1925.

Production of wood distillates and extracts in Canada in 1925 amounted in value to $1,989,996 according to the Dominion Bureau of Statistics at Ottawa. This figure was the lowest recorded since 1922 and compares with corresponding output value of $2,283,422 in 1924 and $2,743,295 in 1923. Only 10 establishments were in operation in 1925; two distillation plants were dismantled during the year.

Representing a capital investment of $2,287,109, the 10 plants gave employment to 309 persons throughout the year, and used materials worth $847,663 in the manufacturing processes. In 1924 an average of 367 persons were given employment, and materials used were worth over a million dollars.

PROCEEDINGS AND NOTICES OF SOCIETIES.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

MEDAL FOR AGRICULTURAL RESEARCH.

The Council desire to call attention to the offer by the Society of a Medal for *Original Agricultural* Research, the regulations governing which are as follows :—

1. The Medal shall be called the Royal Agricultural Society of England's Research Medal. The Medal will be of silver, and money or books to the value of ten pounds will be added.

2. The Medal shall be awarded for a monograph or essay giving evidence of original research on the part of the candidate on any agricultural subject, on any of the cognate agricultural sciences or on agricultural economics. It must be signed by the candidate as the genuine work of the candidate himself.

3. Candidates for the Medal must reside in Great Britain or Ireland, and must not be more than thirty years of age on 29th September, 1926.

4. The Medal shall be adjudged by referees appointed by the Council of the Royal Agricultural Society.

5. The monograph or essay shall be forwarded to the Secretary of the Royal Agricultural Society *on or before October* 30, 1926. The monograph or essay shall be typewritten or printed.

6. If, in the opinion of the referees, no monograph or essay be found to attain a sufficient standard of excellence, they shall be at liberty to reserve the Medal of that year for award as an *additional Medal in* some subsequent year.

7. The monograph or essay of the successful candidate shall be published in the Journal of the Royal Agricultural Society, if, in the opinion of the Council, it is suitable for that purpose. Essays already published shall not be eligible for the Medal.

The last date for the receipt of essays or monographs is October 30, 1926, and probably some *Chemical News* readers would like to submit papers.

THE INSTITUTE OF METALS.

Synopses of Papers presented at the Annual Autumn Meeting of the Institute of Metals. Held in Liége, September 1-4, 1926.

An Account of the Non-Ferrous Metals Industry in the Liége District. By L. BOSCHERON, *Member* (Engis, Belgium). Presented on Thursday, 2 September.

An historical account is given of the development of the zinc industry of the Liége district of Belgium, with particular reference to the discovery of the distillation process by Dony and the subsequent improvement and application of this process. The absence of water power and the high cost of electrical energy in Belgium renders the new electrothermic and electrolytic methods of manufacture of zinc inapplicable method of continuous prodnction would be welcomed.

The Constitution and Structure of the Commercial Aluminium-Silicon Alloys. By A. G. C. GWYER, B.Sc., Ph.D., Member, AND H. W. L. PHILLIPS, B.A., A.I.C., Member (Warrington), with an Appendix upon *The Properties of the Modfiied Aluminium-Silicon Alloys.* By D. STOCKDALE, M.A., Ph.D., Member, AND I. WILKINSON, Member (Warrington). Presented on Thursday, 2 September.

The investigation deals with the constitution, structure, and mechanical properties of modified aluminium-silicon alloys, and a theory based upon colloidal lines is put forward to explain the nature of the modified structures. Examples are given of the application of this theory to other alloy systems. The alloys possess good founding qualities; are appreciably lighter than pure aluminium, and in both chill- and sand-cast states possess a high resistance to shock, excellent ductility, and a high degree of incorrodibility.

Some Mechanical Properties of Silicon-Aluminium Alloys. By J. D. Grogan, B.A., Member (Teddington) Presented on Thursday, 2 September.

The paper describes the sodium and "salts" method of modifying these alloys. The "salts" method is preferred. Some mechanical properties of one inch diameter chill- and sand-cast bars are given. Ternary alloys containing also magnesium or zinc are not superior to the binary alloys.

Some Further Experiments on the Behaviour of Single Crystals of Aluminium Under Reversed Torsional Stresses. By H. J. Gough, M.B.E., B.Sc., Member (Teddington), S. J. Wright, B.A. (Teddington), and D. Hanson, D.Sc., Member (Teddington). Presented on Thursday, 2 September.

The paper is an experimental study of the phenomena exhibited by single crystals of aluminium when subjected to alternating torsional stressing. The resulting distortion under this complex type of straining action is observed using slip-band measurements, and is related to the atomic orientation of the crystals by means of X-ray analysis. The observed complicated system of slip-bands is then shown to be in agreement with the simple law that slip is confined, at any point of the surface of the crystal to one of the octahedral planes and in the direction of the most highly stressed (shear stress) principal lines of atoms. The progressive hardening during a long endurance test has been studied, and the phenomena attending the last stages of the test have been isolated from those of the earlier stages. Some quantitative data regarding hardening by slip have been deduced from ball indentation tests made on cross-sections of the specimens used.

Thermal Anomalies of Certain Solid Solutions. By P. Chevenard, Member (Imphy, Nievre, France). Presented on Thursday, 2 September.

Certain feebly magnetic solid solutions show transformations which are similar to those of ferromagnetic substances in that they occur without change of phase (that is, change of space lattice), they are spread out over a large range of temperature, they are subject to relatively slight hysteresis, and result in anomalies in the different physical properties, dilation, specific heat, resistivity, thermo-electric power, etc. They differ from the magnetic transformations in that the temperature of their occurrence does not vary with change of composition.

Evidence is given of the existence of these so-called " " transformations in a copper-aluminium, nickel-chromium, and copper-nickel solid solutions, and a detailed study is made of their effect on the dilation of the first two groups of alloys and on the resistivity of the last. The variation of the position and magnitude of these anomalies with change of composition is noted, and the coefficients of dilatability and resistivity at each temperature over a wide range have been determined in some cases.

ON THE HARDNESS OF DIFFERENT STRUCTURES IN STEEL.

By Kanzi Tamaru.

(*Abstract from Scientific Paper, Physical and Chemical Research, Hongo, Tokyo.*)

Introduction.

In 1906 and 1908, Boynton reported a systematic investigation of the hardness of the constituents of steel, using Jaggar's instrument, in which the diamond point rotates on the surface of specimens. He gave the following relative hardness numbers :—

	Average Hardness	Ratio
Ferrite	460	1
Pearlite	2,000	4.3
Sorbite	2,400-24,000	5.2-52.0
Troostite	40,500	88.0
Martensite ...	110,000	239.1
Austenite	48,000	104.3
Cementite ...	125,000	271.7

In his method, the resistance offered to abrasion caused by a uniformly rotating diamond point is used for measuring the hardness. This principle of the hardness measurement is quite different from those in application at the present day. The method of test used by the present writer in the investigation of the hardness was the indentation one.

The Hardness of Austenite.

It is well known that in the case of carbon steel, a specimen consisting of austenite alone can not be obtained by quenching, but that such a structure can easily be obtained by adding a certain amount of manganese.

When the carbon content is only in trace, austenite is obtained containing more than 16 per cent. of manganese. With the increase of carbon content, the quantity of manganese required decreases; and with 2.0 per cent. of carbon content 5 per cent. of manganese is sufficient to produce an austenite structure. The austenite is para-

magnetic, but the other structures are all magnetic; hence the purity of the austenite can be detected by a magnetometer. The apparatus used in the present inevstigation was the one constantly used in our Institution. The intensity of the magnetic field in this experiment was 219 gauss and the specimen was 5 mm. in diameter and 7 cm. in length. A deflection of less than 1 mm. was considered to be paramagnetic.

CASE OF CARBON STEEL.

The hardness of austenite at room temperature.

Specimens, 8 mm. in diameter and 3 cm. long, were made from a forged steel containing 1.69 per cent. of carbon. They were heated at 1120-1130° C. for 30 minutes and then quenched in the following three media :

1. Calcium chloride solution at −15° C.
2. Calcium chloride solution at room temperature.
3. Water at room temperature.

It is known that a calcium chloride solution is one of the best quenching media, and hence quenching solutions of different temperatures were used so as to obtain specimens containing different amounts of austenite and martensite. On etching the specimen with picric acid, white martensite *needles are revealed in a ground mass of* brown austenite. A microphotograph of each specimen was taken, and after measuring the area of the martensite by a planimeter, the percentage of this area was calculated. Further, the hardness of each specimen was measured by a Rockwell hardness tester at 3 to 5 different points.

SUMMARY.

The result of the present investigation may be summarised in the following words :

1. The relative composition of carbon and manganese which is just sufficient to obtain austenite by water quenching, has been determined.

2. The *hardness of both austenite and* martensite in carbon steel at room temperature has been found to be 155 and 720 *respectively in the Brinnell scale.*

3. The hardness of austenite in carbon steel has been found to be 10 in the Shore scale at 820° C.

4. The hardness of strained cementite has been found to be 820 and its natural hardness 640 in the Brinell scale.

5. The hardness of austenite in manganese steel both at ordinary and at high temperature has been fonnd to be 182 in the *Brinell scale and 17 in the Shore scale* respectively.

6. The variation of hardness in carbon, nickel and manganese steels with temperature has been measured.

7. The relation of the hardness of quenched steel with regard to the carbon concentration has been determined.

8. The relation between the hardness of a quenched carbon steel and the tempering temperature has been determined.

NOTICES OF BOOKS.

Chemische Bodenanalyse. By PROF. K. K. GEDROIZ. Pp. XII. + 245. Berlin: Gebruder Borntraeger. 1926. Price 12 marks.

Soil chemistry is attracting much attention now and in an agricultural country such as Russia it should assume considerable importance in the future.

Prof. Gedroiz book was first published in Leningrad and has now been translated into German by Miss Frey of the laboratory of the Land Registry Office, Riga. The book deals quite fully with most of the usual methods of soil analysis along purely chemical lines as well as along the lines of the *special technique which it has been neces*sary to introduce. The author gives an account of the ultimate analysis of soils, either through treatment with hydrofluoric acid or fusion with alkalies. Acid extraction methods are described, together with processes for the estimation of unusual or rare elements (*e.g.*, lithium, Rb, Cs, Ti, Zr and Va).

Some of the latest methods, especially American, have been examined and where found successful and suitable they have been adopted and are included. The author, however, seems unacquainted with much that has been done in this country and the continent during the last decade.

It is a gratifying sign that a number of recent Russian works have been considered of sufficient merit to warrant their translation into other languages. There is no doubt that the practice will extend in the near future.

J. G. F. D.

A Review of the Literature Relating to the Normal Densities of Gases. By MARION SMITH BLANCHARD AND S. F. PICKERING. U.S.A. Bureau of Standards. No. 529. Price 15 cents.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

20,090.—British Alizarine Co., Ltd., and Dawson, W. H.—Manufacture of nitro-acridine derivatives. August 14th.

19,960.—British Synthetics, Ltd. Derivatives for dyeing fabrics, etc. August 12th.

10,019.—Deutsche Gasgluhlicht Auer-Ges. Method of producing titanic oxide.

19,852. Hick, G. M., and N. G.—Method of hardening phenolaldehyde condensation products. August 12th.

19,719.—I. G. Farbenindustrie Akt. Ges. —Disinfectants. August 10th.

Specifications Published.

256,385.—Smith, T. B.—Apparatus for drying and neutralising sulphate of ammonia and the like.

251,666.—Staudinger, Dr. H.—Manufacture of an ester of N-allyl-2:6-dimethyl-4-oxypiperidine.

248,359.—Bohm Bruder.—Dyeing apparatus.

Abstract Published.

253,877.—Electrolysis. — Zaidan Hojin Rikagaku Kenkyujo, 31, Kamifuji mae-cho. Komagome, Hongo-Ku, Tokyo.

Maleic and succinic acids, and obtaining.—The acids are obtained by anodic oxidation of furfural. In an example the anolyte consists of a solution or suspension of furfural in 5 per cent. sulphuric acid and the catholyte of 10 per cent. sulphuric acid. The electrodes consist of lead pipes through which cooling water is passed. The current density is about 0.02 amps per sq. cm., and the temperature 35° C. The electrolysis is continued until the anolyte no longer gives the characteristic reaction of furfural with aniline acetate and the anolyte is then concentrated. The product contains 80 per cent. succinic acid and 20 per cent. maleic acid. These are separated by fractional crystallisation. Alternatively, the current may be reversed to reduce the maleic acid to succinic acid. This is crystallised out, dissolved in hot water and recrystallised. In another example, a lead peroxide anode and a current density of 0.06 amps per sq. cm. are employed. The product in this case is mainly maleic acid. Maleic acid may be converted to fumaric acid by adding sufficient sodium chloride to correspond to the sulphuric acid present and boiling. Fumaric acid crystallises out and is recrystallised from hot water. Cerium, vanadium and manganese compounds may be added to the anolyte as catalysts.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

469,155.—Illustration of seal bearing letter A and a TORCH, and words TORCH BRAND.—Chemical substances used for agricultural, horticultural, veterinary and sanitary purposes.—Allen and Hanbury, Ltd., Plough Court, 37, Lombard Street, London, E.C.3.

FABRICOL.

471,197.—Chemical substances used for veterinary purposes.—Osmond and Son, Ltd., Standard Chemical Works, Doughty Road, Brimsby.

UNIVERSITY OF MANCHESTER.

CHEMISTRY COURSES.

A Prospectus containing full particulars of the Lectures and Laboratory Courses qualifying for Degrees in Chemistry will be forwarded on application to the Registrar.

The Session commences on OCTOBER 7TH. Applications for admission to the Research Laboratories should be made to the Director of the Chemical Laboratories.

FULL-TIME TEACHERS Required in the PHYSICS and the CHEMISTRY Departments of the Northern Polytechnic. Good Degree essential. Salary, Burnham scale according to qualifications and experience. Applications to be received by the 6th September. Forms to be obtained from the Clerk to the Governors, Northern Polytechnic, Holloway, London, E.7.

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THE FUNDAMENTAL CONSTANTS OF NATURE.

By HAWKSWORTH COLLINS, B.A. (Camb.).

It will be demonstrated in this paper that *the relative volumes of the elements are the fundamental constants of nature.*

The matter is also intended to be a summary, as short as possible, of thirty-four papers published in the *Chemical News* from March 26, 1923, to the present time.

Since these constants are only invariable at the same temperature, it is necessary to select some particular temperature for the demonstration. The most usual one given with experimental results is 15° C., *i.e.*, 59° F. This is therefore the temperature always employed here.

The relative volumes of the elements were discovered on January 1, 1911, and some thousands of results have now either been published in the *Chemical News* during the last five or six years, or sent to the Nobel Institute. The latter were chiefly organic substances requiring diagrams.

Kopp is generally supposed to have roughly found the relative volumes of a few of the commonest elements; but it was proved in the *Chemical News*, 1921, CXXII., 2 that his results are nowhere near the truth. The chief proof that he was wrong lies in the fact that nothing whatever resulted from his supposed discovery; whereas the discovery of the real relative volumes has led to the discovery of three laws, *viz.*, those of Heat of Formation, Relative Volume and Magnetic Rotation.

Thomsen spent the greater part of his life in making most valuable experiments with regard to heat of formation, and of course his main object was to discover the law, but this eluded him.

Perkin did the same with regard to magnetic rotation; but he also failed to discover his law.

Bruhl did likewise with regard to refractivity, but was unable to observe any sign of a law.

The last two arranged a meeting in order to make an attempt to elucidate matters mutually, but were unable to come to any conclusion as they could not see the slightest sign of any connection in their results.

Bruhl's experiments on refractivity are concerned with only nine elements out of about eighty, so that the matter is not in a position yet for the discovery of a law, or at any rate for the statement that the law has been discovered.

The discovery of the relative volumes of the elements is quite distinct from the discovery of the law of relative volume. The fact that, after the relative volumes were discovered, a law was found from them, proves that they are correct.

Again, the discovery of the heat of formation of each atom in a molecule is quite distinct from the discovery of the law of heat of formation. The fact that, after this discovery, a law was found to connect them, proves that this matter is also correct.

Also the discovery of the magnetic rotation of each atom in a molecule is quite distinct from the discovery of the law of magnetic rotation. The fact that a law was found to connect these results proves that this matter also is correct.

Lastly, the discovery of the optical refractivity of each atom in a molecule is quite distinct from the discovery of the law of optical refractivity, which cannot yet be stated for reasons mentioned above.

The three laws of R.V. H.F., and M.R., all depend upon the discovery of the correct relative volumes. Therefore, the Relative Volumes of the Elements are evidently the Fundamental Constants of Nature. The following formulæ and remarks show this clearly.

If the atomic weights of two elements be divided by their respective specific gravities, it is recognised that the quotients give the relative volumes occupied by single atoms of these elements

$$\text{At. Vol} = \frac{\text{At. Wt.}}{\text{Density}} = \frac{m}{d} = V$$

If the molecular weight of a pure chemical compound be divided by its specific gravity, it is recognised that the quotient gives the sum of the relative volumes of the atoms which form that substance, *i.e.*,

$$\text{Mol. Vol.} = \frac{\text{Mol. Wt.}}{\text{Density}} = \frac{m}{d} = V$$

The molecular refractivity of a pure compound is obtained from the formula

$$\frac{n^2 - 1}{n^2 + 2} \cdot \frac{m}{d} \quad \textit{i.e.,} \quad \frac{n^2 - 1}{n^2 + 2} \cdot V$$

where n is the index of refraction.

The molecular magnetic rotation (M) of a pure compound is given by the formula

$$M = \frac{\alpha . m}{d} \quad \textit{i.e.,} \quad M = \alpha . V$$

where α is the magnetic rotation.

In addition to these the law of heat of formation has been shown to be entirely dependent upon V, and of course the law of relative volume also.

From the above it is evident that seven distinct discoveries have been made :—

(1) The Relative Volume of each atom in a molecule.

(2) The Law of Relative Volume.

(3) The Heat of Formation of each atom in a molecule.

(5) The Magnetic Rotation of each atom in a molecule.

(6) The Law of Magnetic Rotation.

(7) The Optical Refractivity of each atom in a molecule.

The last has been proved to be correct by the discovery of the Co-relationship of the Constants of Nature. This is in the hands of the Nobel Institute, and has not been published on account of the fact that diagrams are necessary and occupy too much space for reproduction in the *Chemical News*.

It is only by the elucidation of such matters as these that Man can ever hope to obtain complete control of the conditions of his existence, and thereby eliminate the many evils to which he is exposed; for they are fundamental matters which concern the substances of which his body and its environment are constructed, and are of infinitely more importance to him than the discovery of the North Pole (*e.g.*), or even of the laws of motion of suns, planets, moons and comets.

THE PHENOMENON OF VALENCY.

By Rajendralal De.

(From the Journal of the Science Association, Maharajah's College, South India.)

Two types of valences, namely, polar and non-polar, are at present recognised by the scientists. In order to avoid confusion, it may be convenient to designate the former type as *electrostatic bond*, retaining the term *valence* for the latter type. Our excuse for altering the nomenclature is that the nature of the combining capacity called polar-valency, is, fundamentally, different from the nature of what is called non-polar. It may be recognised that, on account of the combining bonds, the atoms forming a molecule lose their identity, and, thereby, enable the molecule to behave as a single individual. This behaviour is indicated by the depression of the freezing point of a liquid, caused by a substance dissolved in it. In the case of the substances where the combining bonds of the polar type are believed to be operating, the said depression indicates as if the molecules of the substances dissolved are composed of more than one distinct individual It may, therefore, be suggested that the attractive force which keeps a number of atoms bound together,

and, thereby, enables the entire group to behave as a single individual, is of a character quite different from that brought into play in the case of the so-called polar valence.

As regards the substances yielding ion-radicals, it is assumed that their ionisation is brought about by the transference of electron from one radical to the other. In these cases we may presume that the group displacement law of Fajans and Soddy relating to the expulson of a β-particle from a radio-active element, is applicable. So that the valency in the radical from which the transference of electron takes place, increases by one for each electron transferred. And it may be expected that along with the above process, the reverse of it, namely, the decrement of valency on account of an electron being taken in, should proceed side by side. The valency in the radical receiving the electron should, therefore, decrease by one for each electron received. Hence, the process of ionisation should ultimately result in, for each electron transferred, the gain of one valency-bond and one unit of positive charge of electricity by the positive radical, accompanied by the loss of one valency-bond and the gain of one unit of negative charge of electricity by the negative radical.

We may now see how the above view can accommodate the behaviour of some of the elements. An element is sometimes observed to develop its combining capacity in such a way that its valences appear to increase by two. As an example, we may cite the behaviour of nitrogen in the formation of ammonium chloride from ammonia and hydrogen chloride, or, that of phosphorus in the formation of phosphorus pentachloride from phosphorus trichloride and chlorine. In the formation of such addition compounds, we may find the mechanism of the reaction to proceed according to the view suggested.

Let us take the case of the formation of ammonium chloride. We may consider the nitrogen atom in ammonia to part with one electron and, consequently, having gained an additional valency-bond, to unite with the hydrogen atom of hydrogen chloride, the electron separated being taken up by the chlorine atom as depicted in the following scheme,

$$H_3N \overset{\text{one electron}}{\nearrow} + HCl \longrightarrow \overset{\oplus}{H_4N} \cdots\cdots \overset{\ominus}{Cl}$$

Accordingly, the nitrogen atom in ammonium chloride is considered to have four valences, the ammonium radical being attached to the chlorine radical simply by an electrostatic bond.

Our justification for formulating the above mechanism of reaction rests on the following considerations:

(i) The existence of the ammonium radical, that is to say, a nitrogen atom linked with four hydrogen atoms.

(ii) The investigation of Bragg and other workers of crystal structure, indicating the existence of ion-radicals as distinct from molecules (Bragg, X-rays and Crystal Structure).

(iii) The impossibility of constructing a suitable space model for explaining the optical isomerism of nitrogen compounds, taking nitrogen to be pentavalent.

The difficulty arising out of the hitherto supposed pentavalent nitrogen can be avoided by taking nitrogen to be tetravalent in such cases, the valences being directed towards the corners of a tetrahedron as in the case of a carbon atom. The optical activity would, then, be ascribed to the radical containing nitrogen as is done in the case of the optically active chromium or cobalt complex salts (Werner, *Ber.*, 1911, XLIV., 1887-1898, 2445-2455,—3132-3140). Such a consideration, however, suggests the possibility of synthesising optically active compounds of trivalent nitrogen. Because, when one of its four valences be wanting, the nitrogen atom will be found to occupy one corner of a second tetrahedron, the remaining three corners of which are occupied by the three different radicals as before. The attempt to explain the optical isomerism of nitrogen compounds with the space model of a tetrahedron, has already been made by several chemists (Jones and Dunlop, *Jour. Chem. Soc.*, 1912, CI., 1751; Komatsu, *Mem. Coll. Sci., Kyoto*, 1918, III., 151-159; Neogi, *J. Amer. Chem. Soc.*, 1919., XLI., 622; Phillips, *Jour. Chem. Soc.*, 1925, CXXVII., 2552).

(iv) A consideration of the valency relation of the elements as indicated by their periodic classification.

This relationship as expressed in the first two periods of the classification of Mendeleef and Lothar Meyer is rather regular, and seems to be convincing, although we may sometimes fail to account for the behaviour of their members in all cases When we con-

sider the hydrogen compounds of the elements, we find that the valency increases and reaches a maximum in the fourth group, and then decreases gradually up to the end of a period. The valency thus indicated in the case of nitrogen is three. With chlorine also nitrogen exerts a valency of three. The additional valence of nitrogen in the ammonium radical requires, therefore, an explanation.

We may now commence to examine the behaviour of a few elements of the first two periods, and see if their additive compounds can be explained in the light of the above :

Phosphorus.

The valency of phosphorus in phosphonium salts may be accounted for in the same way as that of nitrogen in ammonium salts. The optical isomerism of phosphorus may also be interpreted by the same model as in the case of nitrogen.

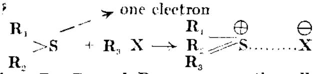
The mode of formation of phosphorus pentachloride indicates that it is an additive compound of phosphorus trichloride and chlorine. There remains, therefore, the probability of its four chlorine atoms being attached by the valency-bonds and the fifth by an electrostatic bond. In fact Holroyd, Chadwick and Mitchell (*Jour. Chem. Soc.* 1925, CXXVII, 2492) have recently found that it, in solution of nitrobenzene, conducts electricity while phosphorus trichloride does not do so.

Sulphur.

Sulphur is divalent with respect to hydrogen. But in sulphonium salts the combining capacity of sulphur is observed to be four. These salts are additive compounds of alkyl sulphide and alkyl halide, *e.g.*,

$$(CH_3)_2S + CH_3.I = (CH_3)_3S.I$$

According to our view, the valency of sulphur in these compounds is three; the radical containing sulphur is attached to halogen by an electrostatic bond as represented below.

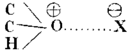


here R_1, R_2 and R_3 represent the alkyl groups and X, the halogen.

The optical derivatives of sulphur obtained by Pope and Peachey (*Jour. Chem. Soc.*, 1900, LXXVII., 1072), and by Smiles (*Jour. Chem. Soc.*, 1900, LXXVII., 1174) are sulphonium compounds. Their optical activity may also be ascribed to the radical containing sulphur, as in the case of the optically active chromium and cobalt complex salts. The space model of a tetrahedron may, in this case as well, account for the optical isomerism of sulphur. We may consider the sulphur atom to be attached to one of its corner and the three alkyl radicals to the remaining three corners.

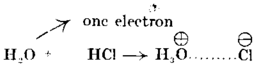
Oxygen.

Oxygen, like sulphur, is also divalent with respect to hydrogen. It forms, however, a class of compounds known as oxonium salts, where the combining capacity of oxygen is taken to be four. The formation of these compounds may be taken to proceed along the same way as that of the sulphonium salts. So that, the valency of oxygen, in these compounds, should be taken to be three, the fourth combining link being ascribed to an electrostatic bond. The compound $C_5H_4O_2$, HCl (γ-pyrone hydrochloride) or $(CH_3)_2$ O, HCl (dimethyl-ether hydrochloride (Friedel, *Bull. Soc. Chim. de Paris*, 1875, XXIV., 160, 241; Wegscheider, *Monatsh.*, 1899, XX., 320), may, therefore, be represented as



where C is carbon atom; X, halogen, and H, hydrogen, and O, oxygen.

It seems likely that H_2O, water molecule, forms an additive compound of the type of oxonium salt with hydrogen chloride and other substances. So that



the ion radicals being $\overset{\oplus}{H_3O}$ and $\overset{\ominus}{Cl}$.

Presuming that hydrochloric acid, *i.e.*, the aqueous solution of hydrogen chloride, is an oxonium compound, it appears that the hitherto supposed hydrogen ion is really the ion $\overset{\oplus}{H_3O}$. And as the so-called hydrogen ions yielded by different substances behave alike, *the probability of the existence of the hydrogen ion in a solution becomes remote.*

BORON.

The combining capacity of boron is sometimes observed to be five (Mellor, *A Comprehensive Treatise on Inorganic and Theoretical Chemistry*, Vol. 5, 19; Ray, *J. Indian Chem. Soc.*, 1925, I., 133-139), while the periodic relation of valency, already referred to, and some of its compounds indicate it to be trivalent. This abnormal behaviour of boron will be found explained in the light of our proposition.

It follows from our standpoint that an increment of the valency of an element should be attended with an equal increment in the number of the electrostatic bond. We notice a similar behaviour in the case of the complex platinum salt. On comparing $[Pt(NH_3)_4]Cl_2$, tetra ammino platinous chloride with $[Pt(NH_3)_6]Cl_4$, hexa ammino platinic chloride, we find that the increment of the secondary valency by two, is accompanied by an equal increment of the primary valency (*i.e.*, the electrostatic bond). It appears that the secondary valency has the same character as that of the combining capacity which we have termed valency in this paper (De, *Jour. Chem. Soc.*, 1919, CXV., 127-134).

We may observe that our proposition regarding the increment of valency explains the formation of the active tri-atomic hydrogen (Venkataramiah; *Nature*, 1920, CVI., 46; Wendt and Landauer, *J. Amer. Chem. Soc.*, 1920, XLII., 930; Thomson, *Rays of Positive Electricity and Their Application to Chemical Analysis*, 2nd edition, 197) and that of the compounds of helium as well (Manley, *Nature*, 1924, CXIV, 861; Boomer, *Nature*, 1925, CXV., 16; *Proc. Roy. Soc.*, 1925, A., CIX, 198-205). The condition of their formation indicates the probability of the loss of electron by the above elements. The reactions may be represented as

$$\text{(i)}\quad H + H_2 \xrightarrow{\text{one electron}} \overset{\oplus}{H} = H_2$$

$$\text{(ii)}\quad W + 2\,He \xrightarrow{\text{one electron}} \overset{\oplus}{W}He_2$$

We wish to discuss further on this subject in a separate paper.

The University of Dacca,
Ramna, Dacca, Bengal.
19th January, 1926.

THEORY OF CURRENT TRANSFERENCE AT THE CATHODE OF AN ARC.

By J. SLEPIAN.

(*Abstract from the "Physical Review,"* XXVII., 4.)

The relatively low temperature of the cathode in the case of such metals as copper and mercury, suggests that thermionic emission from the cathode is not essential and that some other factor may be more important in determining the current carried to the cathode in such cases. It appears that if the gas next to the cathode is sufficiently hot, thermal ionisation in accordance with Saha's equation may account for much of the current to the cathode. Calculation shows that an upper limit for the required temperature is somewhat in excess of 4000°K for Ca, and 6000°K for Cu.

INTRODUCTION.

Although it is generally accepted that a cathode hot enough for thermionic emission is a necessary condition for the existence of an arc, a number of observations have been made which cast serious doubt upon the universal necessity of this condition. By an arc, is here meant a self-maintaining discharge with a drop at the cathode very considerably less than the normal cathode drop for the particular cathode material and adjoining gas in question. Thus H. Stolt found that by sufficiently rapid motion of an arc over its cathode, the cathode would give no evidence of having been subjected to a very high temperature, and the author has shown that transition from a glow discharge to an arc may take place while the cathode is still cold.

The case for the necessity of a thermionically active cathode has been very ably presented in a notable paper by K. T. Compton who concludes that the greater part of the current carried at the cathode is by electrons emitted thermionically. However, the most convincing examples which Compton gives are the carbon and tungsten arc, in which because of the refractory properties of the materials, the cathodes may reach such high temperatures that their thermionic emission is sufficient to account for most of the current. For more volatile materials, such as mercury or copper, the thermionic theory meets a very serious difficulty in that it calls for a cathode temperature far in excess of the boiling

point of the cathode material, whereas Hagenbach and Langbein, in the case of copper, iron, and nickel find by optical methods that the temperatures of the cathodes are actually very near their boiling points.

Thermal Ionization in an Arc, and Theory of Cathode.

In the paper by K. T. Compton referred to above, the theory is very convincingly presented that in the positive column of an arc, the ionization is maintained principally by the high temperature existing there. Using Saha's equation Compton calculates the degree of ionization to be expected at 4000°K, and finds it sufficient to account for the observed conductivity in the positive column of the arc.

It appears now that this theory of thermal ionization in the arc may be used also to explain the passage of current to the cathode, so that it is no longer necessary for the cathode to have a large electron emission or to be heated to a higher temperature than its boiling point. In fact, the thermal ionization in the gas, with reasonable assumptions as to temperature, is such that the arc current may be carried to the cathode by thermally generated positive ions.

Quantitative Test of Theory of Cathode.

To be sound, this theory of the cathode must meet certain quantitative tests. First, the observed cathode drop must be sufficient to carry the necessary current density of positive ions to the cathode. Second, the product of cathode drop and current density must more than make up for the heat lost from the hot gas to the relatively cold cathode.

Langmuir has shown that when a plane electrode in contact with an ionized gas is given a sufficiently negative potential to repel all electrons, the current density flowing to the electrode and carried entirely by positive ions will be independent of the potential and equal to the random positive ion current density in the gas. This random current density, I, is defined as the current corresponding to the number of positive ions per second which pass in one direction through a square centimetre of an imaginary plane in the body of the gas. According to Langmuir,

$$I = \tfrac{1}{4}\, n\, v\, e \qquad (1)$$

where n is the number of positive ions per cm³., v is the average translational velocity of the thermal agitation of the ions, and e is the electronic charge.

The theory of the cathode here being developed, then, clearly requires that I given by (1) shall also be the current density at the cathode.

If n_1 is number of molecules per cm³. in a gas temperature T, then

$$n = n_1 \,.\, x/(1 + x) \qquad (2)$$

where x is the fraction of molecules thermally ionized and is given by Saha's equation for atmospheric pressure,

$$\log \frac{x^2}{1 - x^2} = - \frac{5050\, Vi}{T} + 2.5 \log T - 6.69 \qquad (3)$$

Vi being the ionizing potention of the gas in volts.

For the velocity of agitation v of the ions, we have

$$\frac{1}{2}\frac{M}{N} v^2 = \frac{1}{2} kT, \qquad (4)$$

M being the molecular weight of the ion, N the number of molecules in a gram molecule of substance, and k Boltzman's constant. Also

$$n_1 = n_0 \,.\, 273/T \qquad (5)$$

where n_0 is the number of molecules per cm³ of a gas at 273°K. Substituting (2), (4) and (5) in (1), we obtain

$$I = \frac{273}{4} n_0 e \frac{x}{1 + x} \sqrt{\frac{Nk}{MT}} \qquad (6)$$

For calcium we have $M = 40$, $V_1 = 6.01$, and for copper $M = 63.5$ and $Vi = 7.69$. Substituting these values in (3) and (6), and taking $n_0 = 2.70 \times 10^{19}$, $e = 4.77 \times 10^{-10}$, $N = 6.06 \times 10^{23}$, $k = 1.37 \times 10^{-16}$ curves have been calculated.

Now the current density at the cathode of an arc is of the order of 100 amperes per cm² at atmospheric pressure. On examination it is found that for calcium and copper the temperatures of the vapours need to be from 4000° to 5000°, and 6000° to 7000° respectively for the positive ion density to be sufficient to carry the current to the cathode.

These temperatures are rather higher than those determined experimentally, but two considerations will serve to make these figures acceptable. First of all, this high temperature needs to exist only in a thin layer of gas next to the cathode and will therefore be very difficult to detect experimentally. Secondly, Saha's equation, which is the basis of this calculation, was derived on the supposition of thermodynamic equilibrium. But an ionized gas in an electric field is not in thermo-dynamic equilibrium, since the electrons take energy from the electric field and maintain themselves with a greater energy of agitation than that of the neutral molecules. Thus Langmuir finds that in a mercury arc the electrons have a temperature of over 10,000° K in a gas of less than 400°K. For a gas in an intense electric field therefore, the temperature (of the neutral molecules) *necessary for a given degree of ionization* will be much less than that called for by Saha's equation.

The electrode receiving the current of positive ions, as Langmuir has shown, is separated from the main body of ionized gas by a sheath containing only positive ions and neutral molecules, the electrons being repelled out of this sheath by the electric field. The thickness of this sheath varies with the applied potential, the applied potential being balanced by the space charge in the sheath. Langmuir gives the equation

$$I = \frac{2.336 \times 10^{-6}}{\sqrt{1834M}} \frac{1}{x^2} V^{3/2} \quad 1 + .0247 \sqrt{\frac{T}{V}} \qquad (7)$$

where V is the applied potential in volts, x the sheath thickness in cm, I the current density in amperes/cm^2., M the molecular weight of the ions, and T the absolute temperature.

SPECTROSCOPIC STUDY ON THE DISCHARGE IN HELIUM.

By Toshio Takamine.

(*Institute of Physical and Chemical Research, Hongo, Tokyo.*)

Abstract.

In 1918, Merton observed that the broadening of the helium lines in a condensed discharge is in general quite similar in types with the Stark effect on these lines, and he concluded that the heterogeneous interatomic electric field occuring in such a case of condensed discharge must be the cause of the broadening.

Recently the author had the occasion to try discharge in helium tubes at rather higher pressures than is usually used in spectroscopic work, ranging from a few millimeter of mercury up to nearly one atmospherical pressure.

For electrical excitation of the discharge tube, beside the ordinary condensed discharge, the method of exploding wires first introduced by J. A. Anderson was also tried.

The result showed certain rather interesting features in the spectrum, in that some of the lines showed peculiar distribution of intensity.

Summary.

(1) The method of exploding wires, first introduced by Anderson was applied to the discharge in helium tubes.

An interesting phenomenon was seen in that the lines $\lambda 4922$ ($\nu = 2P - 4D$), $\lambda 4472$ ($\nu = 2p - 4d$) and $\lambda 3203$ (ionized helium line) showing the depression of intensity in the middle of the line.

The cause of this phenomenon seems to be due to the interatomic electric field produced by the very closely packed atoms at high current densities.

2) Condensed discharge in a capillary of a helium tube at fairly high pressure (between ½ and 1 atmosphere) showed a similar phenomenon for the lines λ 6678 ($\nu = 2P - 3D$) $\lambda 5876$ ($\nu = 2p - 3d$) and λ 3889 ($\nu = 2s - 3p$).

In may previous works under similar conditions the cause of this phenomenon is usually attributed as due to the self-reversal of the lines. It is suggested here that perhaps here again the effect of interatomic electric field may be coming into play at least to a certain extent.

General Notes.

MINERAL PRODUCTION OF CANADA, 1924.

The Dominion Bureau of Statistics at Ottawa has just published the Annual Report on the Mineral Production of Canada during the calendar year 1924, from which it appears that the final data for that year show that Canada's mineral production during the twelve months had a total value of $209,583,406.

The statistics relating to the different minerals and the general statistical tables have been prepared as formerly and these have been supplemented by general reviews of the principal mineral industries, (*e.g.*, the copper-gold industry, the silver-lead-zinc industry, the nickel-copper industry, etc.,) and by a section on metallurgical works. In recent years, the value of statistics of this character, covering capital, labour, equipment, etc., has become more generally recognised and the demand for such information has greatly increased.

To meet the demand for the names and addresses of concerns operating in the mineral industry, a list has been prepared and is included in this report; this departure, adapted in 1922, will it is hoped, be found of value.

NOTES ON MANGANESE-BEARING LIMES.

By R. A. Cooper.

As it is stated that a magnesian lime is now being used in some reduction works on account of its manganese content, I think that the following analysis of a representative sample of a consignment of this material may be interesting:—

Total calcium oxide...	36.90%
Magnesium oxide	8.35%
Carbonic acid, etc. (loss on ignition)	25.35%
Silica and insoluble matter	8.88%
Iron oxide and alumina ...	13.22%
Free carbon	1.79%
Manganese oxide Mn_3O_4	2.00%
Manganese dioxide MnO_2	3.28%
Available calcium oxide ...	9.0 %

Assuming that this material is used on account of its available oxygen, it will be seen that in each tone about 1,800lbs. of inert material is to be bought and handled to obtain the advantages of 180lbs. available calcium oxide and 12lbs. oxygen, while other lime must be used to obtain adequate alkalinity.

THE SWEDISH IRON INDUSTRY.

The regrouping of the Swedish iron industry as announced some months ago, appears now to be consummated, although in a form somewhat different from that originally proposed. It had been planned to use a credit of 15,000,000 crowns, to be granted by the Government.

PROCEEDINGS AND NOTICES OF SOCIETIES.

FARADAY SOCIETY.

June 14, 1926.

Explosive Reactions in Gaseous Media. A Note on "The Uniform Movement" During the Propogation of Flame. By W. Payman and R. V. Wheeler.

When an inflammable gas mixture contained in a horizontal tube closed at one end and open at the other is ignited at the open end, the flame produced travels for a certain distance at a uniform speed after which it begins to vibrate backwards and forwards, the general sense of travel being towards the closed end. The initial spread of flame is termed "the uniform movement" of flame, in distinction from the succeeding irregular "vibratory movement," and was first observed by Mallard and Le Chatelier, who regarded its speed as the "normal" speed of propagation of flame by conduction of heat from layer to layer of the gas mixture. Mallard and Le Chatelier concluded that the speed of the uniform movement is a constant for a given mixture contained in any one tube at a given temperature and pressure. Other methods have been suggested for measuring the "normal" speed of propagation of flame, the most important being that due to Gouy, who showed that there is a simple relationship between the area of the surface of the inner cone of a bunsen burner, the rate of flow ofthe gas mixture supplied to the mouth of the burner, and the speed of propagation of flame in that mixture. The work of Gouy has been extended by Michelson, by Mache, and, more recently, by a simplified method, by Hofsäss. The measurement of this normal speed of propagation of flame is of importance when attempting to obtain a measure of the relative inflammabilities of different gases. In our own work we have preferred to use the measurement of the uniform movement of flame, since the values are more directly obtained and are of more direct application.

Although the speed of the uniform movement of flame in an inflammable gas mixture is a physical constant for that mixture in any one tube at a given temperature and pressure, the uniform movement only occurs under specified experimental conditions. If the results are to be of wide practical value as well as of theoretical importance the effect of change of experimental conditions

must be considered. There is a considerable amount of evidence available that the relative speeds of the uniform movement of flame obtained under the specified experimental conditions are directly proportional to the speeds under other conditions, except during the detonation wave. Thus, the speed-percentage curves for the uniform movement are of the same type as those obtained by Michelson and Hofsäss for the "Normalgeschwindigkeit" of the same gas mixtures, whilst the maximum speeds of flame attained by different inflammable gases are in the same proportion to one another in their experiments as in ours. The rate of development of pressure with different inflammable gases mixed with air and contained in a spherical vessel, ignition being at the centre ,is also directly proportional to the maximum speed of uniform movement of flame in the same mixtures. This is shown in Table I. The calculated values for methane as the standard in the equation : (speed of uniform movement) × (rate of attainment of maximum pressure) = a constant.

TABLE I.

Inflammable Gas.	Speed of Uniform Movement of Flame. Cm. per Second. 2.5 cm. Diameter Glass Tube	Time of Attainment of Maximum Pressure from Moment of Ignition at the Centre of a 4-litre Sphere. Seconds. Found	Calculated.
Methane	67	0.037	0.038
Carbon monoxide	120	0.007	0.009
Hydrogen	485	0.053	0.055
Propane	82	0.068	0.068

Similarly, it has been found that the law of speeds applies to the rate of development of pressure in mixtures of complex gas mixtures with air, a result which is not surprising since the rate of development of pressure must depend upon the rate at which the flame spreads through the enclosed inflaming mixture. These experiments emphasise the importance of correlating pressure effects with rates of spread of flame, a point which has received a disproportionately small amount of attention.

THE INSTITUTE OF METALS.

Synopses of Papers presented at the Annual Autumn Meeting of the Institute of Metals. Held in Liége, September 1-4, 1926.

Preliminary Experiments on the Copper-Magnesium Alloys. By W. T. COOK, B.Sc., A.I.C., and W. R. D. JONES, M.Sc., Member (Cardiff). Presented on Thursday, 2 September.

An account of the preliminary experiments of a research on copper-magnesium alloys. The chief feature is the production of sound chill-cast bars free from smooth-sided internal gas cavities by means of a double-melting process, similar to that recently recommended by Archbutt for the production of castings in aluminium free from pinholes. Details are given of the method adopted and of a type of bottom-pouring crucible used to eliminate inclusions of flux and slag. The properties of chill-cast bars containing up to 10 per cent. copper are recorded. The microstructure, macrostructure, and the effects of the double-melting are illustrated by means of photographs.

The Deformation of Tungsten Crystals. By C. J. SMITHELLS, D.Sc., Member, H. P. ROOKSBY, AND W. R. PITKIN (Wembley). Presented on Friday, 3 September.

It is known that when metals are rolled or drawn the crystal fragments tend to take np a definite orientation with respect to the direction of working. In the present paper it is shown that the same effect is produced during the swaging of tungsten rods. The micro-structure and X-ray diffraction pattern at various stages of the swaging of tungsten rods have been examined with a view to understanding the mechanism by which this "preferred" orientation is attained. Three kinds of material have been used, comprising fine-grained rods having 650 grains per sq. mm., and rods in which the crystals had an average diameter of 5 mmc., and occupied locally the full cross-section of the rod.

The Action of Hydrogen on Hot Solid Copper. By CYRIL S. SMITH, B.Sc., D.Sc., Member (Cambridge, U.S.A.), and PROF. C. R. HAYWARD, S.B. (Cambridge, U.S.A.). Presented on Friday, 3 September.

When copper (wire) containing oxygen is heated in hydrogen, maximum brittleness is obtained at intermediate temperatures, and a marked recovery occurs when the action is carried out at temperatures approaching the melting point.

The rate of penetration of hydrogen into cast copper has been determined and certain peculiarities observed. When the oxygen in the copper exceeds 0.07 per cent., the depth of penetration in a given time is greater at about 800° C., than at higher temperatures. A theory is advanced to account for this.

s When brittle "gassed" copper is annealed and forged in a non-oxidising atmosphere, the cracks responsible for the brittleness close, and metal of remarkable properties is obtained.

Development of the Use of Nickel in Coinage. By CAPTAIN F. R. BARTON, C.M.G. (London). Presented on Friday, 3 September.

The paper deals with the historical development of the application of nickel to coinage, and the difficulties encountered and overcome in adapting it to this purpose. In its pure form, as well as a constituent of binary alloys, nickel has been widely adopted during the last half century as a coinage metal. Experience shows that pure nickel coins wear longer in circulation than those made of silver, and that they are equally proof against counterfeiture.

The Constitution and the Physical Properties of the Alloys of Cadmium and Zinc. By C. H. M. JENKINS, B.Sc., A.R.S.M., Member (Teddington). Presented on Friday, 3 September.

This paper contains the results of a study of the metallography and the physical properties of some of the alloys of cadmium and zinc. The constitution and properties of the zinc-rich alloys seems to be considerably influenced by the two polymorphic changes which appear to exist in zinc. One of these changes caused an increase in the solid solubility of cadmium in zinc above the eutectic temperature, the resulting equilibrium diagram is therefore somewhat unusual containing a region representing a completely solid alloy occurring above an area which is composed of both liquid and solid alloys. It has been found that the cold-worked alloys very slowly soften at room temperature, but the effect of ageing does not cause any unfavourable alteration. The zinc-rich alloys should not, however, be annealed subsequently to this ageing. The properties of cast and rolled zinc appear to be improved by the addition of cadmium. The eutectic alloy, previously proposed for use as a medium hard solder, possesses very suitable physical properties for this purpose.

The Primitive Copper Industry of America. Part II. By GEORGE BRINTON PHILLIPS, A.B. (Philadelphia, Pa., U.S.A.). Presented on Friday, 3 September.

"Native Indian Art in Copper." An account of the specimens of hammered copper-arrow heads, tools, and ornamental objects made by prehistoric Indians which have been found in the fields, village sites, and burial mounds in the United States. Many thousands of such objects have been investigated; they show a somewhat sporadic industry, but considerable mechanical skill and artistic taste in their manufacture with stone and bone tools by the aboriginees. The analysis of these hammered copper specimens indicates the source of the metal to be the native copper from the mines of Northern Michigan and not copper brought from Europe.

ACTION OF SODIUM SULPHATE IN SYNTHETIC TANNING MATERIALS.

By EDWARD WOLESENSKY.

(*U.S.A. Bureau of Standards.*)

Hide substance has such a marked affinity for sulphuric acid that it will absorb the acid from a solution of sodium sulphate acidified with acetic acid. The sulphuric acid so absorbed can not be removed even by prolonged washing, the hide substance retaining 1.4 per cent. of its weight of the acid after 72 hours' washing with distilled water.

Furthermore, the sulphuric acid so combined with hide protein can not be completely displaced by a synthetic tanning material, although the latter can itself be partly displaced from combination with the hide substance by sulphuric acid on treatment with a dilute solution of sodium sulphate acidified with acetic acid. Hence, if a hide is treated with a syntan containing a soluble sulphate, it will absorb both sulphuric acid and the synthetic tanning material to a certain extent, depending on the nature of the syntan and the concentrations of the reagents in the tanning bath.

These results apply to the particular syntans studied, and in the absence of other tanning materials. It is also possible that sulphuric acid so combined with the hide protein in leather may not be injurious to the latter.

This behaviour of soluble sulphates in synthetic tanning materials will also lead to error in the determination of tanning material and non-tannins in the analysis of syntans containing soluble sulphates, by methods involving the use of hide powder.

SUMMARY AND CONCLUSIONS.

It has been shown that sulphuric acid and hide substance are not only capable of entering into actual chemical combination with each other, but that the affinity between the two is so pronounced that hide substance is capable of removing sulphuric acid even from a dilute solution of sodium sulphate acidified with acetic acid (approximately 0.5 per cent. of each). Furthermore, the sulphuric acid thus combined in the hide substance is so firmly bound that it can not be removed completely even on prolonged washing with water at ordinary temperatures. The amount of the acid which may remain combined with the hide substance after washing with water for 72 hours is at least 1.4 per cent. of the weight of the hide substance.

It has also been shown that sulphuric acid when once combined with hide substance can not be completely displaced by a syntan, but that, on the other hand, the syntan itself can, to a certain extent, be displaced from combination with hide substance by means of sulphuric acid, even though the latter is present only in the form of its sodium salt in dilute solution acidified with acetic acid.

It therefore follows that if a hide is treated with a solution containing both sodium sulphate and a synthetic tanning material (which is usually an active acid) both the sulphuric acid and the tanning material will combine with the hide to a certain extent. In other words, the neutralisation of the excess sulphuric acid in syntans, by means of sodium hydroxide or any other reagent which yields a soluble sulphate, does not entirely prevent the sulphuric acid in syntans, by means of sodium hydroxide or any other reagent which yields a soluble sulphate, does not entirely prevent the sulphuric acid from reacting with the hide during the tanning process. The extent to which the sulphuric acid and the synthetic tanning agent will combine with the hide under these conditions is not yet definitely known, but it is probable that an equilibrium will ultimately be reached, depending partly on the nature of the syntan and partly on the concentrations of the reagents in the tanning solution. But whatever the amount of the sulphuric acid which will be combined in the leather, the results obtained in the present study indicate that this can not be completely removed by any amount of washing with water at ordinary temperatures. It is possible and even probable that this combined sulphuric acid which remains in the leather after thorough washing will have no injurious effect on it, but this still remains to be definitely ascertained. In any case, thorough washing of the leather after using a syntan which contains any considerable amount of sodium sulphate or other soluble sulphate is always necessary in order to prevent injury from the free sulphuric acid which would result from the interaction of the sulphate with any excess of uncombined sulphonic acid.

On the other hand, if a hide removes sulphuric acid from a solution containing sodium sulphate and a sulphonic acid, it is evident that some of the sulphonic acid (a tanning material) must be left behind in the form of its sodium salt (which is not a tanning material) to take the place of the sulphuric acid which was removed by the hide. This would certainly be objectionable if it occurred to any considerable extent.

Finally, this behaviour of sodium sulphate in syntans must result in appreciable error in the determination of the "non-tannins" (and therefore of tanning material) in such products by any method involving the use of hide powder, not only because sulphuric acid is absorbed by the hide powder and therefore classed as tanning material, but also because an equivalent amount of sulphonic acid is left behind and classed as "nou tannin." This difficulty, however, may be overcome by first precipitating all free sulphuric acid or soluble sulphates from the syntan solution by the addition of an equivalent quantity of barium acetate. If the resulting barium sulphate can not be removed before the treatment with hide powder, a correction can easily be made for it afterwards.

IMPORTS OF COAL INTO GREAT BRITAIN.

Colonel Lane-Fox, Secretary to the Mines Department, in a written Parliamentary answer to Mr. Lawson, states that the quantity of foreign coal which arrived in Great Britain from the beginning of May to August 28, was 7,600,000 tons.

British Association for the Advancement of Science.

SECTION K.—BOTANY.
1860—1894—1926.

ADDRESS BY PROFESSOR F. O. BOWER, Sc.D., D.Sc., LL.D., F.R.S.
PRESIDENT OF THE SECTION.

"*The future of Biology lies not in generalisation, but in closer and closer analysis.*" Bateson (Birkbeck Lecture, 1924).

1926.

From the time that the periodic reduction of chromosomes was recognised as general in organisms showing sexuality, the nuclear cycle has formed a natural foundation for the comparison of the life-histories of plants. The normal cycle may be figured to the mind as a closed circular thread with two knots upon it, syngamy and reduction. Between those knots beads may be strung, one, or more than one, or none. These represent somatic developments, which are normally diploid between syngamy and reduction, haploid between reduction and a fresh act of syngamy. They follow in alternate succession in any normal cycle, but either may be repeated indefinitely by vegetative propagation. Certain questions arise with regard to the evolution of these somata as we see them. The first is, how far are the diploid and haploid somata of the same cycle comparable one with another? The reply will turn upon the constancy of the events of syngamy and reduction throughout descent. If they were constant, then it appears a necessary consequence that the alternating diploid and haploid somata must have been distinct throughout their history; and any similarity which they may show, as in *Dictyota* or *Polysiphonia*, would be homoplastic. It would indeed appear natural that they should be alike in Algæ since they are parts of the same organic life, and live under identical circumstances. It has, however, been suggested that reduction may not be a fixed, but a movable event in the individual life; liable to be deferred or carried over to a later phase, in which case a diploid generation might arise by transformation from an already existent haploid phase. The monospores of the Nemalionales have been cited as possibly convertible in other Red Seaweeds into tetraspores, by some sudden deferring of the act of reduction. I am not aware that this has been advanced by close comparison beyond the positive of tentative suggestion, though the existence of a diploid gametophyte and of a haploid sporophyte in certain abnormal ferns would indicate the possibility of the suggestion being true. Pending the advance of a closely reasoned argument it is best to keep an open mind. Meanwhile the weight of facts hitherto known from plants at large may be held to support the stability of the events of syngamy and reduction during normal descent. The two generations of the same life-cycle would, in the absence of a carry-over of reduction, be homoplastic, not homogenetic.

It is, however, round a second question that divergent views as to alternation chiefly centre. How far are the liploid and haploid somata in the cycles of different types of organism comparable one with another? This is, in fact, the old problem of Pringsheim and Celakovsky. It applies to all plants where somata alternate, but a special interest attaches to the case of Land-Living plants; in particular, we shall trace the origin of the dominant sporophyte of a Land Flora, and inquire whether it originated by *transformation* of diploid developments such as are seen in certain Algæ, or by formation *de novo* through *interpolation*? A clear statement of the former hypothetical alternative was made by Scott in 1911, *viz.*, 'that the Fern with its stem and leaves corresponds to the Seaweed in which stem and leaf are not differentiated, the whole plant being a thallus.' 'On this theory the sexual prothallus and the asexual plant are both alike derived from a thallus, and may once have been perfectly similar to each other.' In alluding to leafy Liverworts and some of the higher Seaweeds as

illustrations, he then remarked that 'these are only analogies, it is true.' But after that the higher Cryptogams came direct from plants of the nature of Algæ than from Bryophyta or any plants at all like them; he added, however, that 'this view is pure hypotheses.' It must, of course, be remembered that these quotations from Dr. Scott's 'Evolution of Plants' (p. 225) were of pre-Rhynie date. A luminous statement of his later views was contained in his address to Section K in Edinburgh in 1921, which will be in the memory of you all.

Church, in his vivacious essay on 'Thalassiophyta' (1919), went much further than this guarded and scientific statement by Scott of 1911. By 'deduction from types still existent in the sea' he assumes 'Algæ of the transmigration' as a bridge between the vegetation of land and sea. His transmigrant Algæ 'appear, in fact, to have been more highly organised than any single algal type at present known to exist in the sea,' and 'to have combined the best features, as factors of the highest grade of progression, of the known great conventional series of marine phytobenthon, and yet to have belonged to none of them.' He boldly fills the gap that puzzles us all by hypothetical organisms that no one has seen, and which he expressly tells us we shall never see (*l.c.*, p. 88). If the discussions of the 'nineties were inconclusive engagements at long range, what is this? It is certainly not that closer analysis advocated by Bateson.

An alternative to such an effort of imagination may be found in the examination of organisms that really exist, or are known to have existed, illuminated by the conception of homoplasy, or, as it is often called, parallel-development. The comparisons should be based upon the recurrent fact of the chromosome-cycle, since this underlies the ontogeny of all plants that show sexuality. Somatic development in sexually produced organisms is seen to be in some measure independent of the successive events in the chromosome-cycle. The somata may be unicellular, existing only as potential gamete or zygote respectively; they need not necessarily be alike in themselves, nor need they appear at the same points in the cycle. For instance, it is found that the pennate Diatoms have diploid vegetative cells, while in the centric Diatoms they are haploid, this latter state being shared by the vegetative cells of the Desmideæ and Zygnemeæ. That a soma should appear at the same point in the cycle of two or more organisms does not necessarily prove that they have had the same phyletic history. The full proof that they did can only follow from the observation of sequences of close relationship which should indicate the successive steps to have been the same if a true homogeny exists. We are, in fact, thrown back upon close comparative observation for tracing truly homogenetic sequences of somatic development, rather than upon the mere position of a given soma in the cycle, or the recognition of its diploid or haploid state. Until such evidence is available, it will be best to hold it as possible that the origin of any somata compared has been homoplastic.

Some such view as this was clearly in the mind of Professor Oltmanns in 1923 (*Morph. und Biol. der Algen*, vol. iii., p. 143). Speaking with the fullest knowledge of the cytologically distinct alternation as it appears in the Algæ, he says: 'When we affirm that an alternation of a gametophyte and a sporophyte is seen in the more highly developed Algæ, that is not the equivalent of saying that all the forms cited betray an affinity to the Archegoniatæ. Just as sexuality may be held to have arisen repeatedly and independently in various groups of the lower organisms, so may the various higher families have carried independently the establishment of two generations. Where a second generation is *present* we may assume that it was independently interpolated, and has developed from small beginnings such as we see in *Œdogonium* or *Sphæroplea*, etc.' If this be admitted for various families of the Algæ, it may be contemplated the more readily for the Archegoniatæ, which are more distinct in their characters from the Algæ than these are among themselves.

No one has yet made out a closely reasoned case for the descent of the Archegoniatæ from the Green, the Brown, or the Red Algæ. The old view that they originated from the Green Algæ has never recovered from the blow delivered by Dr. Allen, when he showed that the reduction in *Coleochæte* takes place in the first divisions of the zygote, and the presumed primitive sporophyte is really haploid, and not cytologically a sporophyte at all. It is a perfectly tenable position to hold that the Archegoniatæ sprang directly from none of these groups, as we know them. In the absence of definite comparative evidence the field appears to be open to an origin of

alternation in the Archegoniatæ by interpolation of a sporophyte *de novo*, developed not in water but in relation to a land-habit. Against such an origin of a sporophyte there is in some minds a strange, and to me inexplicable, preconception. Many years ago Professor Von Goebel drew attention to a curious leaning among morphologists towards reduction-series. It appears as a prevalent psychological phenomenon that men are more prone to admit down-grade sequences than those that are up-grade. But it is clear that in evolution at large there must have been a credit-balance of upward development as a whole, otherwise no multicellular organisms could exist at all. Each morphologist no doubt strikes his own financial balance at the end of the year, and notes justly whether or not his credits meet his debits. Why should he not carry forward the same accurate balance of amplification against reduction into his morphology? But we find him cheerfully accepting evidence of the practical elimination of the gametophyte in Seed-Plants, and contemplating a similar elimination in the Brown Seaweeds, thus making drafts upon his morphological account. When, however, an origin by interpolation of the sporophyte is suggested to him, he regards this morphological asset with something more than suspicion. He will overdraw his morphological balance more willingly than he will pay in assets to his morphological credit.

Here it may be well to consider what rational explanation is now possible for the origin of a diploid generation. The old biological idea that the alternation arose in relation to amphibious life will not suffice, since alternation is seen to exist in fully aquatic Algæ. Nevertheless, the amphibial life may have been one of the sirsumstances that have modified the development, and guided it into the special channel seen in Archegoniate Plants. Svedelius, however, suggests a more general reason for the somatic development of a diploid sporophyte which deserves the most careful attention ('Einige Bemerkungen ueber Generationswechsel und Reduktionstheilung,' 1921). Instead of laying weight upon meiosis as reconstituting the daughter-nuclei, he suggests that the greatest importance of the reduction-division lies rather in its making new combinations of chromosomes possible. He points to the difference between only one reduction in each cycle, as in the simplest organisms, and many as in those that have achieved a higher development; and he concludes that the origin of a large diploid sporophyte is thus an advantageous biological organisation, since it secures many reduction-divisions, and consequently numerous new combinations. This hypothesis has the advantage of giving a general explanation of the origin of a diploid sporophyte, independently of any special circumstances of life under which it came into being.

(*To be Concluded Next Week.*)

CORRESPONDENCE.

THE QUICK AND THE DEAD!

To the Editor of the CHEMICAL NEWS.

Sir,

The *Neues Montagblatt*, a Vienna newspaper quotes an article saying that a young English druggist, living in London, has invented a way of preventing people apparently dead, being buried alive.

As I am the inventor of an apparatus for restoring life in cases of sudden death, I should be very thankful if you could give me the address of the above-mentioned druggist, so that I could get in touch with him.

With thanks in anticipation, I am,

Yours truly,

R. EISENMENGER.

Vienna, VII.,
Mariahilferstrasse 28.
26 August, 1926.

[We are aware of the practice of severing an artery, etc., to ensure that a person still alive is not interred, but we are not acqnainted with any recent discovery or invention of the kind suggested. Possibly some of our readers may be able to supply the information our correspondent desires. —ED., *C.N.*]

NOTICES OF BOOKS.

The Genera of South African Flowering Plants. By E. P. PHILLIPS, M.A., D.Sc., F.R.S.S.Afr., Senior Botanist, Division of Botany.

Students of South African Botany will welcome the coming publication of a convenient handbook on the South African Flowering Plants which is now in the printer's hands.

Since the year 1868, when the late Sir Joseph Hooker published the second edition of Harvey's "Genera of South African Plants," a great need has been felt for a similar work brought up to date. Since that time the exploration of the South African Flora hs mde tremendous strides, especially in Natal, the Transvaal, and South-West Africa, which at that period were almost *terrae incognitae*, but even in the Cape Province many new genera have found, and others have become better known or have been remodelled. Dr. Phillips's book will, therefore, be a great boon to all botanical workers in South Africa even if they have large libraries at theid disposal. It will also be of assistance to teachers in secondary schools and to students of our universities, as well as to officers in Government Departments.

To these the elaborate keys which have been constructed with minute care, and have, as far as possible, been repeatedly tested, should be particuiarly welcome. We expect that Dr. Phillips's work will act as a great stimulus to advance the study of our immensely varied flora.

The book, which will consist of between 500-600 pages of description and keys, will be sold at £1 per copy. Orders may now be placed with the Government Printer, Pretoria, or the Superintendent, Government Stationery Office, Capetown.

Chemical Reviews (July).

This quarterly (which fills a place of its own in the chemical world) is issued by the American Chemical Society (and published in London by Baillière, Tindall and Cox, 8, Henrietta Street, Covent Garden), at 5 dollars per year to non-members.

The July issue contains exhaustive contributions on Catalysis and Auto-Oxidation, by Charles Moreau and Charles Dufraisse; The Properties of Surface Films on Liquids, by Neil K. Adam; A Review of Photochemistry by W. Albert Noyes, Jr., and Louis S. Kassel.

The publication is to provide a vehicle for the appearance of comprehensive analytical reviews and summaries on topics of interest to chemists especially, papers of undoubted value, though not necessarily the original research of the authors.

Experimental Researches and Reports published by the Department of Glass Technology. Vol. VIII., 1925. The University of Sheffield. By PROFESSOR W. E. S. TURNER. 190 pp., with several plates.—A very useful book on the technology of glass.

Abridged Scientific Publications from the Research Laboratories of the Eastman Kodak Company. Vol. IX., 1925. 230 pp. Eastman Kodak Company, Rochester, New York.

U.S.A. BUREAU OF STANDARDS PUBLICATIONS.

Gold, Silver, Copper, Lead and Zinc in Idaho and Washington in 1924. By C. N. GERRY. Price 5 cents.

Iron Ore, Pig Iron and Steel in 1924. By ERNEST F. BURCHARD AND HUBERT W. DAVIS. Price 5 cents.

Coke and By-Products in 1924. *By* F. G. TRYON AND H. L. BENNIT.

Quarry Accidents in the U.S.A. during the Calendar Year 1924. By WILLIAM W. ADAMS. Price 15 cents.

Some Characteristics of Quenching Curves. By H. J. FRENCH AND D. Y. KLOPSCH (Technological papers). Price 10 cents.

Weights and Measures—Report of the Eighteenth National Conference of Representatives from Various States held at the Bureau of Standards, Washington, D.C., May 25 to May 28, 1925. Price 50 cents.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

245,128.—I. G. Farbenindustrie Akt. Ges. —Manufacture of new azo-dyestuffs.

20,487.—Chemische Fabrik auf Actien, Vorm. E. Schering.—Manufacture of esters of isoborneol, etc. August 19th.

20,638.—Geere, E. W.—Preparation of chemical substances. August 21st.

20,169.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of photographic silver halide emulsions. August 16th.

20,507.—Tatum, W. W.—Anthraquinone dyes, etc. August 19th.

20,511.—British Dyestuffs Corporation, Ltd.—Vat dyestuffs, etc. August 19th.

Specifications Published.

256,711.—Fleet, W. F., Potter, H. V., and Damard Lacquer Co., Ltd.—Synthetic resin product.

256,808.—Chemische Fabrik Gresheim-Elektron.—Manufacture of azo dyestuffs.

242,990.—Farbwerke Vorm. Meister, Lucius & Bruning.—Process for preparing calcium nitrate capable of being strewn.

254,086.—Synthetic drugs.—Cassella & Co., Ges., L., of Frankfort-on-Main, Germany.

Abstract Published.

Acylamino-oxyphenylarsenoxides are prepared by gentle reduction of the corresponding arsinic acids. The products are useful in the treatment of diseases caused by spirochaetae. Examples are given of the production of 4-acetylamino-3-oxyphenyl-1-arsenoxide, 3-acetylamino-4-oxyphenyl-1-arsenoxide, 3-chloro-4-oxy-5-acetylaminophenyl-1-arsenoxide and 3-methyl-4-oxy-5-acetylaminophenyl-1-arsenoxide by treatment of the corresponding arsinic acid with hydriodic and sulphurous acids. Specification 230,487 is referred to.

3-*Methyl-4-oxy-5-acetylaminophenyl*-1-*arsinic acid* is obtained from 4-amino-2-acetylamino-6-methyl-1-phenol by substituting the arsinic acid residue for the amino group in known manner.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

VARICOPHTIN BRAND.

471,440.—Chemical substances prepared for use in medicine and pharmacy.—H. R. Napp, Ltd., 3 & 4, Clements Inn, Kingsway, London, W.C.2.

SPASMONAL BRAND.

470,847.—Chemical substances prepared for use for veterinary purposes.—H. R. Napp, Ltd., 3 & 4, Clements Inn, Kingsway, London, W.C.2. August 25th.

SUBTRAX.

469,826.—Chemical substances used in manufactures, photography, or philosophical research and anti-corrosives.—E. Taeschner Chemisch Pharmazeutische Fabrik, of Neue Grunstrasse 4, Berlin, C.19, Germany. August 25th.

DARTRING.

470,089.—Chemical substances used in manufactures, photography, or philosophical research, but not including paints, cements or anti-corrosives or the like.—Vereinigte Chemische Werk Aktiengesellschaft, Salzufer 16, Charlottenburg, Germany. August 25th.

KENVAR.

471,726.—Chemical substances used in manufactures, photography, or philosophical research and anti-corrosives.—John Fuller & Co., Ltd., 58, Minster Street, Reading, Berkshire. August 25th.

BRITISH PATENT 108,853.
IMPROVEMENTS IN EXPLOSIVES.

The Owner of this Patent wishes to grant Licence or to come into relation with someone competent for the Industrial Working of said Patent.

For particulars write to Mr. A. Van Damme, 7, Rue Du Montenegro, Brussels (Belgium).

UNIVERSITY OF MANCHESTER.

CHEMISTRY COURSES.

A Prospectus containing full particulars of the Lectures and Laboratory Courses qualifying for Degrees in Chemistry will be forwarded on application to the Registrar.

The Session commences on October 7th. Applications for admission to the Research Laboratories should be made to the Director of the Chemical Laboratories.

FULL-TIME TEACHERS Required in the PHYSICS and the CHEMISTRY Departments of the Northern Polytechnic. Good Degree essential. Salary, Burnham scale according to qualifications and experience. Applications to be received by the 6th September. Forms to be obtained from the Clerk to the Governors, Northern Polytechnic, Holloway, London, N.7.

THE CHEMICAL NEWS

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PEPTISATION AND COAGULATION OF SOME HYDROXIDE SOLS.

By S. L. JINDAL AND N. R. DHAR.
(*Allahabad University.*)

In a previous paper[1] it has been shown that the electric conductivity of a solution of NaOH did not appreciably change on the addition of hydroxides of chromium, aluminium, lead and mercury, whilst in the case of zinc hydroxide the conductivity of NaOH solution appreciably decreased when $Zn(OH)_2$ was added to it. Hence it was concluded that the solutions of $Al(OH)_3$, $Cr(OH)_3$, $Pb(OH)_2$, HgO, and $Cu(OH)_2$ in NaOH are cases of true peptisation and not of chemical combination. On the other hand, in the case of $Zn(OH)_2$ we get more of chemical combination than of peptisation.

In a later paper[2] it was shown from cataphoretic experiments that the hydroxides of Cu, Cr, Al, Zn and Co when dissolved in the least quantity of alkali, exist as negatively charged colloids by the preferential adsorption of OH′ ion from the alkali.

In the same paper it was shown that in the ammoniacal solutions of Cu, Ni, Zn and Cd salts, a part of the metal exists in the eoxplex condition and another part as negatively charged colloid by the adsorption of OH′ ions.

In this paper we have investigated the coagulation of hydroxides of Al, Cr, Zn, and Be, when dissolved in alkalies by the addition of electrolytes.

We have also investigated the protective influence of cane sugar, starch, glucose, agar-agar, gelatine, etc., on these hydroxides when peptised by alkalies.

The following results were obtained:—

ALUMINIUM HYDROXIDE.

When $\frac{N}{12.5}$ KOH was added drop by drop to 2 c.c. $\frac{M}{100}$ $Al_2(SO_4)_3$, a white precipitate was formed and it vanished when 3 c.c. of the alkali was added. This solution could not be coagulated in 24 hours by a saturated solution of KNO_3. On the other hand, 2 c.c. of $\frac{M}{10}$ $AlCl_3$ can be just dissolved by 1.14 c.c. $\frac{N}{12.5}$ KOH and this clear solution cannot be coagulated in 24 hours by $\frac{M}{20}$ $Ba(NO_3)_2$ or $\frac{M}{2}$ $BaCl_2$.

The experimental results show that more alkali is necessary for peptisation when $Al_2(SO_4)_3$ is used than when $AlCl_3$ is used. Hence it appears that the sulphate ion has a more coagulating influence than chloride ion in the peptisation of $Al(OH)_3$.

It appears, therefore, from the foregoing results that a very stable sol is obtained when caustic alkali is added to aluminium salts.

CHROMIUM HYDROXIDE.

When $\frac{N}{12.5}$ solution of KOH was added

[1] Chatterji and Dhar, *Faraday Soc. Discussion*, October, 1920.

[2] Dhar and Sen, *Jour. Phys. Chem.*, XXVII., 376 (1923).

drop by drop to 2 c.c. of $\frac{M}{100}$ $Cr_2(SO_4)_3$ solution, a green precipitate was formed which did not dissolve even after adding 10 c.c. of the alkali. When, however, different volumes of the alkali solution taken in a separate test tube were added to 2 c.c. of $Cr_2(SO_4)_3$ solution, only 2 c.c. of the alkali were found to dissolve the precipitate which is first formed.

The coagulating effect of $2N.KNO_3$ was investigated on the above solution, and the volume in each case was made up to 10 c.c., and the results are given below :—

TABLE I.

(2 c.c. of $\frac{M}{100}$ $Cr_2(SO_4)_3$ solution taken in each case.)

$\frac{N}{12.5}$ KOH c.c.		2N KNO_3 c.c.	Observations.
2	...	—	Clear solution, but became turbid in a few seconds.
2.5	...	—	Slight turbidity in 24 hours.
2.5	...	0.5	Turbid in 15 minutes.
3	...	—	No turbidity in 24 hours.
3	...	0.5	Turbidity in 90 seconds; rate of turbidity very slow.
3	...	1.0	Turbidity in 30 seconds.
3	...	1.5	Turbidity in 10 seconds.
4.0	...	0.5	Turbiditiy in one hour; coagulation complete in 48 hours.
4.0	...	1.0	Turbidity in 4 minutes; coagulation complete in 48 hours.
4.0	...	1.5	Turbidity in 1½ minutes; rate of coagulation was quick.
5	...	0.5	Turbidity in 1½ hours; the rate of coagulation is extremely slow.
5	...	1.0	Turbidity in 1½ hours; the rate of coagulation is extremely slow.
5	...	1.5	Turbidity in one hour.

TABLE II.

(2 c.c. of $\frac{M}{100}$ $CrCl_3$ solution taken in each case.)

$\frac{N}{12.5}$ KOH		2N KNO_3	Observations.
6.25	...	—	Clear solution examined after 24 hours.
18.75 31.25 43.75 68.75		2	All became turbid in 24 hours; the extent of turbidity decreased with the increasing amount of the alkali.
81.25	...	1.875	Coagulated in 48 hours.
121.875	...	1.875	Quite clear after 24 hours; slight turbidity after 48 hours; half coagulation after 72 hours.
121.875	...	5	Quite clear after 24 hours, but became turbid after 48 hours.

TABLE III.

$\frac{N}{12.5}$ KOH		$\frac{M}{20}$ $Ba(NO_3)_2$	Observations.
121.875	...	2	Coagulated in 24 hours.
187.5	...	2	„ „ „ „
257.8125	...	2	„ „ „ „
328.125	...	2	„ „ „ „

TABLE IV.

Total volume 20 c.c.

$\frac{M}{100}$ $Cr_2(SO_4)_3$ = 2 c.c.

$\frac{N}{6.25}$ KOH = 1.5 c.c.

Time of first appearance of turbidity = 10 seconds.

$\frac{M}{20}$ Cane Sugar amount added in c.c.		2N KNO_3 required to coagulate in c.c.	$\frac{M}{10}$ Glucose amount added in c.c.		2N KNO_3 required to coagulate in c.c.
—	...	1.5	—	...	1.5
0.1	...	2.5	0.1	...	2.0
0.2	...	3.5	0.2	...	2.5
0.3	...	5.0	0.3	...	3.5
0.4	...	7.0	0.4	...	3.5
0.5	...	9.5	0.5	...	4.25
0.6	...	13.0	0.6	...	5.0
			0.7	...	6.0
			0.8	...	6.0
			0.9	...	8.25
			1.0	...	9.25
			1.1	...	10.25
			1.2	...	11.5
			1.3	...	12.5

(1.5 c.c. of $\frac{N}{6.25}$ KOH was not added in the cases below).

1.62% Starch amount added in c.c.		2N KNO_3 amount required to coagulate in c.c.	$\frac{N}{10}$ KOH amount added in c.c.		2N KNO_3 required to coagulate in c.c.
—	...	1.5	2.5	...	1.25
0.1	...	2.0	2.7	...	1.5
0.2	...	2.5	2.9	...	2.25
0.3	...	3.25	3.1	...	3.0
0.4	...	4.5	3.3	...	3.5
0.5	...	6.0	3.5	...	4.0
0.6	...	7.5	3.7	...	4.5
0.7	...	9.0	3.9	...	5.0
0.8	...	10.5	4.1	...	6.0
0.9	...	12.0	4.3	...	7.0
1.0	...	14.0			

Addition of gum-arabic, agar-agar and gelatine did not stabilise the chromium hydroxide sol.

The above results show that:—

(*a*) Caustic potash is a good peptising agent in this case as more of the electrolyte is necessary for coagulation of $Cr(OH)_3$ with the increasing amount of KOH present in the solution.

(*b*) The whole of the chromium hydroxide can be coagulated by means of KNO_3 or $Ba(NO_3)_2$ from the colloidal solution.

(*c*) Cane sugar, glucose, starch act as stabilizing agents because with a constant amount of the alkali more of the electrolyte is necessary to coagulate the hydroxide with the increasing concentration of the above-mentioned peptisers.

(*d*) Gum arabic, agar-agar and gelatine do not stabilize the chromium hydroxide sol.

Zinc Hydroxide.

$\frac{N}{12.5}$ KOH was added to 2 c.c. of $\frac{M}{100}$ $ZnSO_4$ drop by drop. A white precipitate formed which did not dissolve in a moderate excess of KOH; but when 1 c.c. of $\frac{N}{12.5}$ KOH (or more) was added at once a clear solution was obtained.

Table V.

$\frac{M}{100}$ $ZnSO_4$ amount added in c.c.	$\frac{N}{12.5}$ KOH added in c.c.	2N KNO_3 c.c.	Observations.
2	1	—	Clear solution, but became turbid in a few seconds.
2	2	—	Clear solution, but turbidity appeared after a minute and the rate of appearance of turbidity was slow.
2	3	—	Clear; slight turbidity after 24 hours.
2	4	—	Clear even after 24 hours.
2	3	2	Turbidity at once.
2	4	2	Clear; turbidity after 24 hours.
2	16.25	2	Clear even after 24 hours.
2	16.25	4.125	Clear even after 4 days.

Table VI.

$\frac{M}{100}$ $Zn(NO_3)_2$ amount added in c.c.	$\frac{N}{12.5}$ KOH added in c.c.	$\frac{M}{20}$ $Ba(NO_3)_2$ c.c.	Observations.
2	16.25	1	A white precipitate of $Zn(OH)_2$ was seen after 24 hours. The clear solution contained a great deal of zinc.
2	16.25	3	
2	28.75	2	
2	28.75	3	
2	53.75	2	
2	53.75	3	A small amount of $Zn(OH)_2$ obtained after 24 hours; major portion of Zn is not precipitated.
2	112.5	2	
2	112.5	2	
2	187.5	3	No precipitate in 24 hours.
2	187.5	4	

TABLE VII.

$\frac{M}{100}$ $Zn(NO_3)_2$ amount added in c.c.	$\frac{N}{12.5}$ KOH added in c.c.	$\frac{M}{2}$ $BaCl_2$ c.c.	Observations.
2	53.75	4	All became turbid at once. Even after 24 hours, majority of zinc remains in the solution.
2	75.0	4	
2	112.5	4	
2	187.5	5	

TABLE VIII.

$\frac{M}{100}$ $Zn(NO_3)_2$ amount added in c.c.	$\frac{N}{12.5}$ KOH added in c.c.	KNO_3	Observations.
2	8	added in crystals	Zinc was present both in the residue and filtrate; greater quantity being present in the later case, even after 4 days.
2	9		
2	10		
2	16		

Starch, cane sugar, glucose, gum, agar-agar and gelatine did not peptise the zinc hydroxide sol.

The above experiments seem to prove that :—

(a) When small quantities of KOH are present zinc hydroxide is peptised, but the solution is so unstable that part of the zinc hydroxide is precipitated within a short time.

(*b*) When larger quantities of KOH are present KNO_3 is able to coagulate a part of the zinc hydroxide.

(*c*) The larger portion of zinc is not coagulated by electrolytes. Only a small amount of zinc is coagulated.

(*d*) The ordinary non-electrolytes, *e.g.*, cane sugar, glucose, starch, gelatine, agar-agar, and gum arabic, have no stabilizing action on zinc hydroxide.

Thus we find that zinc is nearly always present as zincate in the solution, while only a small quantity is in the colloidal state.

BERYLLIUM HYDROXIDE.

TABLE IX.

$\frac{M}{100}$ $Be(NO_3)_2$ = 2 c.c.

$\frac{N}{6.25}$ KOH amount added in c.c.	2N KNO_3 added in c.c.	Observation after 24 hours.	Observation after 48 hours.
1	—	Clear	Slight turbidity.
1.5	—	,,	Slight turbidity.
2.0	—	,,	Clear.
1.0	0.25	Gelatinous precipitant.	
1.5	0.5	,, ,,	
2	0.75	,, ,,	
2	3.0	,, ,,	Be present in the filtrate.
2	1.0	,, ,,	Be present in the filtrate, even after 8 days.
2.5	1.0	,, ,,	
3.0	2.5	,, ,,	
3.0	3.75	,, ,,	Be present in the filtrate, even after 7 days.
3.5	4.0	,, ,,	
4.0	(From 3 to 12 c.c.)	No precipitate	
4.5	(From 3.5 to 5 c.c.)	,,	
5	(From 5 to 7 c.c.)	,,	

TABLE X.

$\frac{M}{100}$ $Be(NO_3)_2$ = 2 c.c.

$\frac{N}{6.25}$ KOH = 2 c.c

Total Volume 20 c.c.

0.0405 % Gum arabic amount added in c.c.		2N KNO_3 added in c.c.	Observation after 24 hours.
0.2	...	1	No precipitate.
0.2	...	1.25	Precipitate.
0.4	...	1.75	Precipitate.
0.6	...	(From 1.75 to 3 c.c.)	No precipitate.
0.8	...	(From 2 to 3.5 c.c.)	No precipitate.

TABLE XI.

$\frac{M}{40}$ Cane Sugar amount added in c.c.		2N KNO_3 added in c.c.	After 24 hours.
—	...	0.75	Precipitate.
0.4	...	0.50	Precipitate.
0.4	...	0.75	Precipitate.
1.0	...	0.75	No precipitate.

TABLE XII.

$\frac{M}{40}$ Glucose amount added in c.c.		2N KNO_3 added in c.c.	After 24 hours.
0.4	...	0.5	No precipitate.
0.4	...	0.75	Gelatinous precipitate.
0.4	...	1.0	Gelatinous precipitate.
1.0	...	0.75	Gelatinous precipitate.

TABLE XIII.

0.2025 % Gelatine amount added in c.c.		2N KNO_3 added in c.c.	After 24 hours.
0.8	...	—	No precipitate.
0.8	...	0.5	Turbid.
0.8	...	0.75	Precipitate.
0.8	...	1.0	Precipitate.
1.0	...	0.75	Precipitate.

TABLE XIV.

0.162% Agar-agar amount added in c.c.		2N KNO_3 added in c.c.	After 24 hours.
0.1	...	1.0	No precipitate.
0.1	...	1.25	Precipitate.
0.1	...	1.5	Precipitate.
0.2	...	1.25	Precipitate.
0.2	...	1.5	Precipitate.
0.3	...	1.5	No precipitate.
0.3	...	1.75	Precipitate.
0.4	...	2.25	Precipitate.
0.4	...	2.5	Precipitate.
0.5	...	2.75	No precipitate.
0.5	...	3.0	Precipitate.
0.6	...	3.5	*No precipitate, but precipitate after 48 hours.*
0.6	...	3.75	No precipitate, but precipitate after **48** hours.
0.7	...	4.0	Precipitate.
1.0	...	(From 0.5 to 5 c.c.)	No precipitate.

TABLE XV.

0.0405 % Starch amount added in c.c.		2N KNO_3 added in c.c.	After 24 hours.
0.1	...	1.0	Precipitate.
0.2	...	1.0	No precipitate.
0.2	...	1.25	Precipitate.
0.2	...	1.5 0	Precipitate.
0.4	...	1.75	No precipitate.
0.4	...	2.0	Precipitate.
0.4	...	2.25	Precipitate.
0.6	...	3.5	No precipitate.
0.6	...	3.75	Precipitate.
0.6	...	4.0	Precipitate.
0.8	...	(From 4 to 5.25 c.c.)	No precipitate.

From these experimental results we conclude that :—

(*a*) Beryllium hydroxide forms a more stable solution with small quantities of KOH.

(*b*) Part of beryllium always remains uncoagulated when KNO_3 is used, whilst a greater part is coagulated.

(*c*) Starch, KOH, gum-arabic, and agar-agar are found to be good stabilizing agents.

(*d*) Cane sugar, glucose and gelatine have only a slight stabilizing action.

(*e*) The data for starch and agar-agar are characteristic of stabilizing agents.

(*f*) The data for KOH is different from *those of starch and agar-agar.* This may be due to some chemical action between $Be(OH)_2$ and KOH.

Thus we find that in the case of $Be(OH)_2$ a greater part exists in the colloidal state, while a small portion is present in the combined state.

SUMMARY AND CONCLUSION.

1.—When an excess of KOH is added to a solution of an aluminium salt $Al(OH)_3$ is at first precipitated and then goes into solution. No precipitation takes place when electrolytes like KNO_3, $BaCl_2$ $Ba(NO_3)_2$ are added. Hence on the addition of alkali to aluminium salts stable sols are produced.

2.—In case of a chromium salt, $Cr(OH)_3$ passes into solution in excess of KOH forming a colloidal solution. No evidence of complex formation is obtainable.

3.—When zinc salt solution is treated in the above manner a greater part of zinc exists in the complex state forming potassium *zincate*, while only a *small* quantity goes to form a colloidal solution of zinc hydroxide.

4.—The case of beryllium is reverse of that of zinc. Here it is found that a *greater portion of beryllium* exists *in the* colloidal state while a smaller portion of beryllium is present in the complex state.

Chemical Laboratory,
Allahabad University,
Allahabad, India.
8 May, 1926.

General Notes.

HALF CENTURY OF CHEMISTRY IN AMERICA 1876-1926.

America is getting old. It can record half a century's striking progress in chemistry. This event is celebrated by a Golden Jubilee number of its Journal, which consists of over 250 pages of appropriate letterpress and several pages of interesting photographs of men prominent in the chemical history of the country during the past fifty years. Notable among the illustrations is a reproduction of the group of noted chemists which met on July 31, 1874, to celebrate the centenary of the discovery in 1774 of oxygen by Priestly, which was presided over by Dr. Priestly, great-grandson of the discoverer.

There is given an interesting account of the inaugural meeting of the American Chemical Society on April 6, 1876. This account is supplemented by a readable article by Frank W. Clarke, on the Evolution of the American Chemical Society. There are many other articles dealing with the aims, objects, and activities of the Society. It is interesting to learn that the membership of the Society, which numbered 230 in 1876, 238 in 1890, and 2,919 in 1905, consists this year of no fewer than 14,808 members. The annual subscription is $15, or $300 for life membership. The Society has a Reserve Fund of $108,656.

EXAMINATIONS FOR CERTIFICATES AS MINE MANAGERS & SURVEYORS.

Examinations for first and second-class certificates of competency as managers and under-managers of mines will be held on 24 and 25 November, 1926, at Edinburgh, Newcastle-upon-Tyne, Sheffield, Wigan, Cardiff and Birmingham. The written part of an examination for certificates of qualification as surveyors of mines will be held at the same centres on 25 November, 1926.

Applications for the necessary forms should be made not later than 6 October, 1926. In order that the appropriate forms may be sent, it is important that candidates should state whether they have already sat at one or more of the Board's examinations. Letters should be addressed to the Secretary, Board for Mining Examinations, Mines Department, Dean Stanley Street, Millbank, London, S.W.1.

TRADE OF BRITISH GUIANA IN 1925.

Imports into and domestic exports from British Guiana during the last year totalled 13,960,483 dollars and 14,242,059 dollars respectively, states the British Guiana Blue Book for 1925.

AMERICAN AGRICULTURAL IMPLEMENT EXPORTS.

An increase of about 27 million dollars, or 44 per cent., over the previous twelve months is recorded in the value of exports from the United States of agricultural implements during the past fiscal year.

OFFICIAL INSTRUMENTS FOR AERIAL PHOTO-SURVEY.

Photographic survey from the air, now so rapidly developing, places no little demand upon the optician, not merely for the very large and rapid photographic lenses used for exposing, but also for optical devices which insure that the aeroplane is piloted in parallel straight lines to and fro, so that every square yard of the ground below is photographed in its turn, in regular order, without omissions. To do this properly over any very large area calls for very special optical equipment, because the course of the aeroplane over the ground may be seriously modified by the wind, and it may follow a materially different path over the ground from that indicated by the compass bearing. It is absolutely necessary for an observer to be constantly checking the "drift" and preventing errors arising and accumulating due to wrong estimation of wind, or change in its direction or strength.

To provide apparatus for carefully following the movement of the objects below, and verifying how the aeroplane really does move over the ground, provides the optician with some difficult problems to solve, as, in an aeroplane, obstructions to a clear view abound on every side.

In addition to the equipment in the aeroplane, further very special equipment is needed to carry out the work of making the maps from the negatives exposed from the air; projection apparatus is required for this of no little elaboration. British opticians are to the fore in dealing with all these new optical problems, and this was very evident from an inspection of the exhibition of optical instruments recently held at the Imperial College of Science and Technology in London.

GERMAN DYE INDUSTRY.

His Majesty's Consul-General at Cologne has forwarded to the Department of Overseas Trade the following extract from the *Deutsche Bergwerks Zeitung*, of recent date, dealing with the German dye industry on the world market.

The total annual German exports of dyes and dyestuffs amounted before the war to 260 million Kgs., at a value of 300,000,000 marks. At that time, people spoke of a world monopoly of the German industry on the dye market. This was not quite correct as, even at that time, Germany did not possess a complete monopoly, although between 75-80 per cent. of the world's requirements in dyes were covered from Germany and in certain products it may even have possessed a real monopoly, due to its technical superiority. As in many other things, here, too, the world war brought about fundamental changes. In England, France, Italy, Japan, and the United States of America, in the course of the war new concerns in the chemical industry were established, partly with the help of considerable State funds. After the war these industries were ,of course, not content to cover the requirements of their own countries in dyes and dyestuffs, but tried to find new markets, and thus large markets were lost to Germany. The effects of these proceedings are reflected in the German export statistics for dyes.

CANADA'S INCREASING ZINC PRODUCTION.

Recent announcement of the resumption of the export of zinc concentrates by the Consolidated Mining and Smelting Company of Canada directs attention once more to Canada's increasing production of this metal. Canada is again apparently producing more zinc ore and concentrates in British Columbia than the present plant and refinery at Traid can take care of, notwithstanding that the capacity of this plant was increased during 1925 to a total of 200 tons of zinc per day.

The production of zinc at Trail for the first half of this year is reported as 29,849 tons, as against 15,711 tons during the first half of 1925. The total production of zinc in Canada in 1925, including the metal in concentrate exported, was 55,335 tons, as against 49,455 tons in 1924, and 30,208 tons in 1925. A total of from 70,000 to 75,000 tons appears to be in sight for 1926.

Canada has thus within ten years risen to the position of fifth place amongst the world's producers of zinc metal in refined form and to practically the same position from the point of view of production according to origin o fore.

COMMONWEALTH INSTITUTE OF SCIENCE AND INDUSTRY.

The Officer in Charge for H.M. Trade Commissioner at Melbourne reports that the first session of the Council for Scientific and Industrial Research was held recently. Among the questions which will be immediately investigated by the Council are:—Cattle and plant diseases and pests; liquid fuels—to ascertain the yield of alcohol locally from Australian hardwoods, and to ascertain whether it can be produced at a sufficiently low price to compete under normal conditions with other liquid fuels; cold storage and transport of fruit, and freezing and chilling of beef.

The Institute also propose to send eight specially selected Australian graduates abroad for training. It is understood that two of these graduates will undergo a course at the British Fuel Research Station at Greenwich, two at the Low Temperature Research Station at Cambridge, one in research in pottery and ceramics, two in forestry research, and one in plant diseases.

INDUSTRIAL CHEMISTRY AND THE SALTERS' INSTITUTE.

The Salters' Institute of Industrial Chemistry has, with the approval of the Salters' Company, made the following awards for the year 1926-27:—

Fellowships Renewed—Mr. H. S. Pink, University College, Nottingham, and University of Oxford (Fellow, 1924-25, 1925-26), at the Massachusetts Institute of Technology; Mr. V. E. Yarsley, Birmingham University (Fellow, 1924-25, 1925-26), at the Polytechnic, Zürich; Dr. R. Campbell, Armstrong College, Newcastle-upon-Tyne, and University of Oxford (Fellow, 1925-26), at the Department of Chemical Engineering, University College, London.

Fellowships Awarded—Mr. E. A. Bevan, East London College, University of London; Mr. R. M. Deanesly, University of Oxford; Mr. R. Edgeworth Johnstone, College of Technology, University of Manchester; Mr. H. B. Spalding, University of Oxford.

SPECIAL LIBRARIES CONFERENCE.

The Association of Special Libraries and Information Bureaux is holding its Third Conference during the week-end, September 24-27, at Balliol College, Oxford. The Rt. Hon. the Viscount Burnham will speak at the opening dinner. Papers are to be given on various problems affecting the collection and distribution of information by experts, including Dr. de Vos Steenwijk, of the League of Nations, and Mr. Kaiser, of the Engineering Societies' Library (New York), who will speak on "Systematic Indexing."

The Conference is open to all interested; as accommodation is strictly limited, those wishing to attend should communicate without delay with the Secretary of the Association at 38, Bloomsbury Square, W.C.1.

THE RELATIVE MERITS OF MONO-, DI-, AND TRICALCIC PHOSPHATES AS SOIL FERTILISERS.

By G. Ingham, M.A. (Oxon.), A.I.C.

(*Extract from the Journal of the South African Chemical Institute*).

It is very generally conceded that plants obtain from the soil solution the mineral elements they need, and hence the solution of a fertiliser is of paramount importance.

It is evident, however, that solubility in water is not a criterion, because such water-insoluble fertilisers as basic slag and bone-meal are little, if at all, inferior to water-soluble super-phosphate, and moreover, the latter becomes water-insoluble very soon after being applied to the soil.

It is now held that one of the chief advantages of a water-soluble phosphate is its more even distribution through soil, where is is precipitated in an exceedingly fine state of division.

Various solvents have been used as a means of distinguishing those phosphates which are readily available to plants from those which are not. Of these, the following may be mentioned : 2 per cent. citric, 1 per cent. citric, oxalic, acetic, aspartic, $\frac{N}{5}$ nitric, and $\frac{N}{20}$ carbonic, and ammonium citrate.

The 2 per cent. citric solubility standard for phosphatic fertilisers has been very generally adopted in Great Britain and the Dominions, and is embodied in the various Fertiliser Acts of those countries.

General Conclusions.

In the present state of our knowledge of crop production under South African conditions the following conclusions seem to be justified :—

1.—The most generally useful form of phosphate, whether alone or in combination with other fertilisers, is superphosphate. It has the advantage of easy diffusion through the soil, and although it soon becomes precipitated in a water-insoluble form, it is present in an exceedingly fine state of division and is readily available to plants. The small amount of water-soluble P_2O_5 which is still present up to a week or month after application (depending on the character of the soil) probably stimulates the activities of useful micro-organisms, thus ensuring a supply of easily available nitrogen early in the season. Super-phosphate is ,however, not suitable on very acid soils.

2.—A mixture of a soft rock phosphate like Egyptian, with an equal amount of superphosphate, and which may be regarded as precipitated di-calcium phosphate, is almost equal to superphosphate in most cases, and is superior to it on sour soils.

3.—Rock phosphates — especially the softer, friable varieties—are of considerable value for direct application to the soil when they are very finely ground. They approach basic slag in efficiency on sour soils, and are likely to be of most value on such soils given a sufficient rainfall. They are unsuitable for use on soils containing carbonate of lime.

It is very desirable that more experimental field work should be done in order to determine the exact value of phosphate rock as a fertiliser, and the conditions under which it is most effective.

Some of the factors that enter into the question are :—

(*a*) The physical character of the rock, *e.g.*, its softness, friability, fineness of grinding, solubility, etc.

(*b*) The nature of the soil. A fair amount of organic matter should be present. No good results can be expected on calcareous soils.

(*c*) The nature of the crop. Legumes and cruciferæ will give better results than cereals.

(*d*) Rainfall should be 25 inches and upwards per annum.

It is possible that if the above conditions are observed, phosphate rock may be found equal or superior to superphosphate in certain cases and if so, it is important that the limits of its usefulness should be clearly defined.

It is unfortunate that so far no considerable deposits of phosphates suitable either for superphosphate manufacturer or for direct application to the soil have been discovered in South Africa. The Langebaan deposit, which was rather promising, has proved to be disappointingly small in amount, and both the Saldanha Bay phosphate and the apatite of the Northern Transvaal belong to a hard and insoluble variety of phosphate rock. Hence the only suitable rocks for direct use at present are derived from other countries, and of these Egyptian, Gafsa, and Algerian phosphate seem most suitable.

BRITISH ASSOCIATION.

SECTION K.—BOTANY.

1860—1894—1926.

ADDRESS BY PROFESSOR F. O. BOWER, Sc.D., D.Sc., LL.D., F.R.S.

PRESIDENT OF THE SECTION.

(*Continued from Page* 174, *Sept.* 10, 1926.)

DEVONIAN FOSSILS AND A LAND FLORA.

We may here leave aside any detailed study of alternation in the Thallophytes, though it is full of interest, and the investigation of it rich in promise; particularly that of the Brown Seaweeds, as last year's proceedings of the Section have shown. This year we may concentrate on the Land Flora, and inquire how recent discoveries may have affected our outlook on it. Notwithstanding that the years since 1894 have been marked by discoveries of the first rank, I see no reason to alter my belief in an interpolated sporophyte in the Archegoniatæ, except in respect of the primary causality; nor do I relinquish the view that the two generations are homoplastic and not homogenetic. Indeed, the new evidence appears to me to strengthen rather than to oppose the position previously stated. I see no need materially to modify the biological reasoning which I offered in 1890 in explanation of the formal difference in Land-Plants between the alternating generations, nor the recognition of the stabilising influence of the amphibious life upon them. But the new discoveries have altered the aspect in certain particulars, and in nothing more than in the relations of the Bryophyta to the rest.

The most impressive event of recent times in the sphere of morphology has certainly been the recognition and constitution of a new class of vascular plants. The disclosure of the fossils of the Rhynie Chert, of early Devonian age, is not only notable as introducing in unusual detail a type of vegetation barely hinted at before, but also because those early land-plants present material of the highest importance for comparison. The new class of the Psilophytales was founded to receive them together with the old Devonian fossil *Psilophyton*, and some others; while their relation to the living Psilotaceæ is recognised. These rootless plants together present a new facet upon the problem as to the origin of members in vascular plants, though they do not wholly resolve it. Apart, however, from such conclusions as the new facts may suggest, they introduce a tonic effect into morphology. Something positive is actually seen, and of very early existence, as a set-off against reasoning from data so often isolated and insufficient, or even purely imaginary. For a balanced statement on land-vegetation viewed in the light of the newly acquired facts one cannot do better than refer to Chapter VI. of Dr. Scott's book on 'Extinct Plants and Problems of Evolution,' 1924. Discussing the relation of the Bryophytes to other Archegoniatæ, he remarks how Kidston and Lang had pointed out that the three phyla, Pteridophyta, Bryophyta, and Algæ, are undoubtedly brought nearer together by the Rhynie discoveries; and I may be pardoned for re-quoting from him a passage of my own (*l.c.*, p. 205): 'Long ago it was remarked that the widest gap in the sequence of plants was that between the Bryophytes and the Pteridophytes. It is within this gap that the newly discovered fossils take their natural place, acting as synthetic links, and drawing together more closely the whole sequence of land-living, sporangium-bearing plants :' Under the influence of these and other late discoveries the Bryophyta are coming into their own. Not only has the problematical *Sporogonites* been described by Halle from the Devonian rocks, but undoubted Liverworts of the Carboniferous Period have been disclosed by the refined methods of Walton. These events coincide with the advent of the Psilophytales, the most sporogonium-like of all vascular sporophytes. It seems there may be a natural place for *Anthoceros* at last, as Campbell tells us.

The effect of the establishment of the Ryniaceous type on the comparison of the parts of the sporophyte is important; in particular the question of the origin of the root and leaf may be canvassed afresh. We see a class of early rootless, land-living sporophytes, sharing this feature with the Psilotales, and we may reasonably hold them to represent a primitive type. On the other hand, we see in all Pteridophyte embryos which have a suspensor that the root, often late in appearance, is a lateral appendage on the embryonic spindle. Moreover, the root asises as an exogenous growth in *Phyllogiossum*, and in certain species of *Lycopodium*, as do also the enigmatical rhizophores of *Selaginella*. Provisionally, then, we may conclude that the root is a late addition to the plant-body in descent, and that it was in the first instance some form of exogenous branch at the base of the primitive sporophyte, such as is seen in the Psilotaceæ and in *Asteroxylon*.

Much greater interest and more consecutive reasoning centres on the question of the foliar developments of vascular sporophytes Studies on 'Leaf-Architecture' and passages dealing with that subject in my book on Ferns, vol. i. have shown that by inductive comparison based on an analysis of plants now living, we may arrive at a theoretical origin of leaves of the Fern-type from a dichotomously branching system; and already in 1884, long before the discovery of the Psilophytales, this conception had been tentatively extended to include the axis as well, though the material facts such as we now possess were not then in evidence. It was also concluded from comparison of living plants that the sporangia were originally distal on the branches. Thus the Psiloyphtales supply in actual fact a sub-aerial type already contemplated as a result of inductive argument. If this origin of a Fern-shoot by sympodial development from a dichotomous branch system, such as that of the Rhynie fossils, be true, there would be no need to draw upon supposititious 'Algæ of the transmigration' to explain the origin of leaves of the Fern-type, for sub-aerial plants would be seen to have originated such leaves for themselves. Any similarities between Algæ and Ferns in respect of foliar appendages would appear only as interesting facts of homoplasy.

This does not, however, exhaust the question of foliar origin. Such plants as *Thursophyton* and *Asteroxylon*, as well as the living Psilotaceæ, present features which suggest a second type of foliar appendage. Lignier has long ago designated these as 'phylloides,' while his 'cauloides' correspond to the leaves of ferns. I do not propose here to discuss this difficult question. The present purpose is fully served by showing that induction from the facts of land-living plants alone will now give a reasonable history of the origin of leaves of the Filicinean type, without any need to refer to some transmigrant Alga to explain it. Why should we assume any limit to the capacity of Organic Nature to originate new members Or to do this in more than one way, and in more than one phyletic line At the back of the theory of Transmigration is the assumption that she cannot, or probably would not, do this. But a wide comparison of things now living before our eyes, or that have lived, shows that she can, and that she has done it repeatedly.

Palæobotanical discovery has been greatly advanced within the period under review. The features of the vegetation of Mesozoic time are becoming clearer than ever before under the hands of Professor Seward. The Carboniferous Flora has been richly presented to us by Williamson, Scott, Oliver, and Kidston in Britain, and by Continental workers such as Renault, Zeiller, Bertrand, Nathorst, and Solms-Laubach. We are now able to substitute something positive in place of vague surmisings. Not only do the new facts illuminate our knowledge of plants now living, but they also apply a check upon theories as to their origin. Latterly a vision is becoming ever more and more real of a Devonian flora, revealed by Kidston and Lang at home, and by other workers in Scandinavia, in Germany, and in America. Given more extended collecting, an improving technique, and the fortune of finding more material as well preserved as that at Rhynie, who knows but what the coming decades may see the land of the Devonian period clothed before our eyes by a flora no less stimulating and even more suggestive than that of the coal? But though Devonian lands are the earliest yet known to have supported a sub-aerial flora, the highly advanced structure of such a fossil as *Palæopitys Milleri* suggests that we are still far from visualising the actual beginnings of Land Vegetation. Moreover, the mixture in the Rhynie Chert of Algal types with vascular land-plants presents at the moment a problem as perplexing as it is ecologically strange. It is always difficult

to estimate justly the times in which we live; but we may well believe that the future historian of botany will note the present period as one specially marked by successful study of the floras of past ages, and by the increasing cogency of their comparison with the vegetation of the present day.

The 'Annals of Botany' as an Historical Document.

Perhaps too much of your time has been claimed for morphological questions, which are closely related to the dates of the three meetings of the Association here in Oxford. The brief space that remains may be devoted to a more general survey of the period which these dates cover. In this we could not do better than to take as an index the pages of the 'Annals of Botany,' for the existence of which we owe a deep debt to the Oxford Press. In 1860 there was no organised laboratory teaching of Botany in any University in Britain; and as yet there was no journal of the nature of the 'Annals.' But the revival of close observational study in Botany under Huxley and Thiselton Dyer at South Kensington in the early 'seventies, recorded last year by various writers in the 'New Phytologist,' was beginning to take effect in 1881, when the British Association met in York. There the outstanding feature was the address of Hooker on Geographical Distribution. This and the papers by Bayley Balfour on Socotra and by Baker on Madagascar were all that really mattered botanically, and almost all the contributions were systematic or regional in subject. The revival of the laboratories had not yet fructified. At this time all the work that was done in laboratories was called 'physiology,' as distinct from systematic botany which was conducted on dry specimens in the herbarium. In 1887, six years after the York meeting, the 'Annals of Botany' was founded through the activity of Sir Isaac Bayley Balfour, and a small committee of guarantors whose personal security induced the Clarendon Press to make the venture. From the start that journal has paid its way. The forty stately volumes form a record, between the pages of which you may read the history of botanical progress in Britain, and in some degree also in the United States, for American botanists have always been with us in its pages. In the first issues of the 'Annals,' morphology and systematic botany preponderated, and from the proceedings of the meeting of the Association in Oxford in 1894 we see that this was still so. That meeting witnessed a crisis in the affairs of botany in Britain. A newly established Section I of Physiology assumed that the functional activities of plants would be swept, together with those of animals, into its hands. Up to this time Section D had been the undivided section of Biology. An irregular cleavage of interests was set up by this claim, for the zoologists were mostly willing to give up their physiology, but the botanists were not. Their refusal to accept divorce of form from function contributed to, or at least coincided with, the foundation of a separate Section K of Botany, and has dictated the policy of British botany ever since.

As we pass from 1894 to the current period we perceive a marked shifting of the interest of botanists from the study of form to that of the intimate constitution and functional activity of plants. Whole fields of colloidal chemistry and physics, of quantitative physiology, of cytology and genetics, of ecology, of fungology and bacteriology, have been opened up. The present century has been specially marked by the extension of opportunities for physiological research, by better equipment of departments in the universities, and by the foundation of independent establishments carrying on experimental inquiry in its broadest application. This is rapidly bringing the science into closer relation with Imperial and social aims. It is needless to specify, but the effect of it all is plainly written in the pages of the 'Annals.' Experimental results have gradually taken the preponderant place over description and comparison, as is amply shown in the last January number. 'For better, for worse,' the pendulum has definitely swung over from the extreme systematic position of half a century ago, through a phase of prevalent morphology (or perhaps we should better say of organography), to an extreme physiological position at the present time. Some of you may even have felt that this address is in itself an anachronism, in that it has not touched upon the moving physiological questions of the day. While I may claim none the less to sympathise with physiological aspirations, I do not assent to any ultra-physiological aspect of botany that would degrade or minimise the comparative study of form. '*Medio tutissimus ibis*' is still a true maxim. The laboratory physiologist, dealing with the things of the

moment, cannot safely detach himself from the things o fthe past as recorded in heritable form. He should not allow himself to be immersed in statistics and neglect history. The pendulum has gone full swing, within a period of about half a century; but we may confidently anticipate a return towards some middle position.

BRITISH ASSOCIATION.

ABSTRACTS.

On the Direction of Electrons Emitted by the Photo-electric and Compton Effect. By PROF. W. WIEN.

It is well known that the number of photo-electrons expelled by polarised Röntgen rays has its highest value in the direction of the electric force of the incident wave. This result is in accordance with the electro-magnetic theory of light.

On the other hand, the emission of electrons by the Compton effect is a quite differeut phenomenon. Kirchner has made observations by stereoscopic photographs made of the tracks originated by Compton electrons in a Wilson case. By the stereoscopic observation is it possible to settle the direction in space of the electrons. Kirchner found that the number of electrons has its maximum at right angles to the electric vector. Though this result can be derived from the geometrical constellation, it seems paradoxical because the classical theory shows no force at all in that direction.

On the Asymmetry and Intensity of Spectral Lines Split in the Electric Field Connected with the Direction of Impacts Originating the Emission of Light. By PROF. W. WIEN.

The Balmer lines of canal rays, split by the Stark effect, show a remarkable asymmetry of intensity, which is reversed with the field. In some recent new work Wierl has shown that if the observation is made in a high vacuum, the asymmetry disappears. Therefore the asymmetry is effected by colllisions of the moving atoms.

If canal rays of hydrogen are shot in a vessel filled with nitrogen, one has only moving atoms of hydrogen. Then one finds an asymmetrical intensity. If canal rays of nitrogen are going in hydrogen, the asymmetry is opposite, the impact on the hydrogen atoms having now the opposite direction.

This result shows that only the direction of the impact in relation to the direction of the field is responsible for the acymmetry of the lines. The asymmetry does not last any appreciable time, for it vanishes if the atoms pass after the collisions into a high vacuum.

The Gyro-magnetic Electron. By PROF. VESSOT KING.

A charged sphere in rotation was shown by Maxwell as long ago as 1870 to give a uniform internal field, and an external field equivalent to that of a magnetic doublet. The writer has considered the problem of determining the fields due to a spinniug electron moving with uniform velocity v making any direction with the axis of spin, taking into account the deformation or contraction of the electron boundary into an ellipsoid of axes a and $a(1-v^2/c^2)^{\frac{1}{2}}$, the short axis being in the direction of motion. Regarding this as a real, physical deformation, the energy of the electrostatic and magnetic fields, internal and external, separates into two terms, one translational, the other due to components of spin $(\omega_1\omega_2\omega_3)$. The final result is

$$T = mc^2 + \tfrac{1}{2}(A\omega_1{}^2 + B\omega_2{}^2 + \omega_3\ ) + \text{constant} \qquad (1)$$

In the first term, $m = m_0/(1-v^2/c^2)^{\frac{1}{2}}$ where $m_0 = \frac{2}{3}e^2/a$ and account is taken of the boundary stresses (probably magnetic in origin) which keep the electron in equilibrium. The electrodynamie moments of inertia may be rigorously evaluated for the simple type of spinning electron considered, and in general may be expressed in powers of $\beta^2 = v\ /c$ in the form

$$A = I(1 + a_1\beta^2 + a_2\beta^4 + \ .\ .\ ),$$
$$B = C = I(1 + c_1\beta^2 + c_2\beta^4 + \ .\ .\ .) \qquad (2)$$

where $I = \frac{1}{3}m_0a^2$ is the moment of inertia of the spinning electron at rest. Applying Lagrange's equations to the rotations expressed by T as kinetic energy, the precessional motion of the electron is determined by Euler's equations,

$$A_1\omega = L_1 \quad C\omega_2 - (C-A)\omega_1\omega_3 = L_2 - Ck\omega_2$$
$$C\omega_3 + (C-A)\omega_1\omega_2 = L_3 - Ck\omega_3 \qquad (3)$$

$(L_1L_2L_3)$ being couples from nuclei in atomic systems, or due to the magnetic forces of the radiation field. The precessing electron has magnetic moments proportional to $(\omega_1\omega_2\omega_3)$ whose periodic variations thus give rise to electro-magnetic radiation of the same frequency. The constant k is a simple type of damping factor due to the loss of rotational energy by radiation. Under no forces the stable configuration of the electron is easily seen from (3) to be with the axis of spin along the direction of motion. When disturbed the frequency of precessional motion and of emitted radiation is seen to be, if Ω_1 is the intrinsic spin,

$$2\pi\nu = \Omega_1(C - A)/C = \Omega_1(c_1 - a_1)\beta^2 (1 + b_1\beta_2 + b_2\beta^4 + \ . \ . \ . \ ) \qquad (4)$$

If we denote

$$h\Omega_1 = \pi c_2 m_0/(c_1 - a_1), \qquad (5)$$

where $(c_1 - a_1)$ is a numerical constant equal to 2/5 for the simple model considered, we have to a first approximation a relation between *precessional electron radiation* and *velocity* in the form

$$h\nu = \tfrac{1}{2} m_0 v^2, \qquad (6)$$

the well-known photo-electric equation, while *Planck's constant h becomes a fundamental characteristic of a rotating electron expressed in terms of spin by equation* (5).

This purely classical interpretation appears to be the key to radiation problems generally. With similar hypotheses as to spinning protons as constituents of atomic nuclei, the theory of slightly perturbed, simple orbits under an inverse-square law of electrostatic attraction from the nucleus, with the fundamental relations (6), leads to the series formula for hydrogen and helium spectra and in more complex cases to the S, P, D and F series, with the correct value for the Rydberg constant. Perturbations of orbits due to variation of mass with velocity, external electric and magnetic fields, with in some cases slightly different interpretations ,lead to formulæ the correct type of fine structure, Zeeman (uormal and anomalous) and Stark effects. The fundameutal formula (6), used in conjunction with a Maxwellian distributiou of electrou velocities, also leads with reasonable hypotheses as to electron orbits in a space lattice to Planck's formula for black-body radiation and the associated formulæ for specific heats.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE FARADAY SOCIETY.

Physical Phenomena at Interfaces, with Special Reference to Molecular Orientation.

A general discussion on this subject will be held on Friday, 1 October, 1926, at the Chemical Society's Rooms, Burlington House, Piccadilly, W.1., beginning at 2.30 p.m.

PROGRAMME.

2.30 to 4.30.—Dr. E. K. Rideal, Introductory Address; Prof. H. Freundlich, Electrification at Interfaces; R. K. Schofield, Electrification at Interfaces; Dr. W. E. Garner, Adsorption on Solids; Dr. G. Shearer, Orientation in Solids. General Discussion.

5 to 6.30.—N. K. Adam and G. Jessop, Insoluble Films on Liquid Surfaces; Prof. Dr. E. Gorter, On the Spreading of Proteins; Prof. W. Ramsden, Adsorption of Proteins; Dr. S. Sugden, The Arrangement of Molecules on the Surface of Pure Liquids. General Discussion.

NOTICES OF BOOKS.

The U.S. Bureau of Standards has issued *Tables and Graphs for facilitating the computation of Spectral Energy Distribution by Planck's Formula*, consisting of 7 sheets, by M. K. FREHAFER AND C. L. SNOW.

Using the equatiou for Planck's formula in the form :—

$$\frac{E\lambda}{E_m} = \left(\frac{A}{\lambda\theta}\right)^5 . \left(e^{\frac{C_2}{A}} - 1\right) . \left(e^{\frac{C}{\lambda\theta}} - 1\right)$$

a table has been made with values of $\lambda\theta$ and corresponding values of $\frac{E\lambda}{E_m}$. For any given temperature the wave lengths in the visible, and partly in the ultra-violet and infra-red regions can be readily obtained from $\theta\lambda$. The set can be had for 35 cents.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

20,992.—British Alizarine Co., Ltd.—Production of dyestuffs from indanthrene. August 26th.

20,971.—Demann, W.—Method of purifying resin containing acid.

20,956.—Everatt, R.W.—Preparation of aromatic amines, etc. August 25th.

21,068.—Abbott Laboratories. — Arseno bismuth compounds, etc. August 26th.

21,264.—Newbery, G.—Manufacture of acyl derivatives of dihydroxy diamino-arsenobenzene. August 28th.

246,833.—Bakelite Ges.—Process for obtaining phenol aldehyde condensation products in a purified form.

257,170.—Eisenstein, Dr. A.—Process for separating fatty acids for glycerides.

250,208.—Deguide, C.—Process for purifying silicates of baryta.

250,199.—Chemische Fabrik Auf Actien (Vorm. E. Schering).—Process for dehydrating formic acid.

Printed Copies of the full Published Specification may be obtained from the Patent Office, 25 ,Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

Abstract Published.

254,667.—Urea derivatives.—I. G. Farbenindustrie Akt.Ges., Frankfort-on-Main, Germany.

p-p^1-Diaminodiphenylurea or its derivatives symmethically substituted in the nuclei is prepared by acting with urea on p-phenylene diamine or its derivatives substituted in the nucleus. The reaction is carried out preferably at an elevated temperature and in the presence of an inert diluent such as o-dichlorbenzene. Examples are given shownig the preparation of p-p^1-diaminodiphenylurea and 4 : 4^1-diamino-3 : 3^1-dimethyldiphenylurea, the temperature used being 110-130° C.

The Latest TRADE MARKS

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APHAROL.

470,986.—Chemical substances prepared for use in medicine and pharmacy, but not including aperient medicines or the like. — British Colloids, Ltd., The Crookes' Laboratories, 22, Chenies Street, Tottenham Court Road, London, E.C.1. September 1st.

ULTRACTINA.

471,172. Chemical substances prepared for use in medicine and pharmacy.—K. Hoefelmayr, Kempten Immenstadterstrasse 30, Kempten/Allgau, Germany. September 1st.

CHORIOTROPE.

471,599.—Chemical substances prepared for use in medicine and pharmacy.—British Colloids, Ltd., The Crookes' Laboratories, 22, Chenies' Street, Tottenham Court Road, London, W.C.1. September 1st.

DIGICARDIN.

470,190.—Pharmaceutical preparations. — Aktien-Gesellschaft Hommel's Haematogen, Josephstrasse 20, Zurich, Switzerland. September 1st.

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A COMPACT AND COMPREHENSIVE SERIES OF REACTIONS AND TABLES IN CHEMISTRY.

By ROBERT SAXON, B.Sc., F.C.S.

(*Continued from Page 73.*)

THE SIXTH GROUP.

The number of ways of preparing hydrogen and oxygen is great. We cannot very well study one without the other. We give here a few methods of preparing each. The *most direct is the electrolysis of water which* has been referred to hitherto. To liberate hydrogen we rely on the greater affinity of the alkali, alkaline earth metals, magnesium or zinc, aluminium, iron, carbon or silicon, for oxygen. A great catalyst with these last two is lime, bringing in the tendency to form carbonate or silicate.

HYDROGEN.

i Na/HOH - NaOH/H, also alkali and alkaline earth metals.

ii Na/CH_3OH - $NaOCH_3/H$, as i, also C_2H_5OH, etc.

iii $Al/3KOH$ /t $K_3AlO_3/3H$

iv $2AlHgx/6HOH$ /bp $2Al(OH)_3$ $xHg/6H$

v $3FeO/HOH$ /t $Fe_3O_4/2H$

vi $3Fe/4HOH$ /t $Fe_3O_4/8H$

vii Fe/HOH / FeO/2H

viii $Al_2Si_4/8Na/18HOH$ - $2Al(OH)_3/4Na_2SiO_3/15H_2$

ix $3FeSi_6/40HOH$ /t $Fe_3O_4/18SiO_2/80H$

x (a) CaC_2/CO /300d $CaO/3C$

(b) $CaO/COHOH$ /500d $CaCO_3/2H$

xi (a) $BaSO_4$ /2C /t $BaS/2CO_2$

(b) $BaS/4HOH$ /rt $BaSO_4/8H$

xii $BaSO_4/4MnO$ /wt $BaS/4MnO_2$ (warm)

$BaS/4HOH$ /1000d $BaSO_4/8H$

xiii $Zn/2NaOH$ /wt $Na_2ZnO_2/2H$

xiv $C/2Ca(OH)_2$ /t $CaO/CaCO_3/4H$

xv $FexSi/2NaOH/HOH$ n/- $Na_2SiO_3/xFe/4H$

Here the *n* says that heat is evolved—meaning at the ordinary temperature. There is here the pull of the silicon for the oxygen, that of the sodium base for the silica thus formed, and the insolubility of the silicate. Ferrous hydrate tending to form will assist in the liberation of more hydrogen.

xvi Si/Na_2SiO_3 /2HOH n/- $Na_2Si_2O_5/4H$

xvii $HCOONa/NaOH$ /t $Na_2CO_3/2H$

xviii $Na_2C_2O_4/2NaOH$ /t $2Na_2CO_3/2H$

xix $.Fe/CO_2/HOH$ - $FeCO_3/2H$

xx $2Na/H_2SO_4$ n/- $2Na:SO_4/2H$

or expressed to show that the acid is dissolved in water, and therefore not strong :—

$2Na/2H:SO_4$ n/- $2Na:SO_4/2H$

It should be noted that when a compound is shown thus dissolved and ionised the number (2 in this case) has nothing to do with the part following the ionisation symbol :. There are 2 of Na, but only one of SO_4.

Also alkali and alkaline earth metals, Be, Mg, Al, Cr, Mn, Zn, Cd, Fe, Co, Ni, Sn, and Sb and Bi if alloyed with a strongly positive metal like zinc.

xxi Na/HCl n/- NaCl/H. Also metals as xx.

xxii Be/2KOH K_2BeO_2 2H. Also other soluble hydroxides.

xxiii CaH_2/2HOH - $Ca(OH)_2$/4H. Also other hydrides.

xxiv $Ca(OH)_2$/CO /700d $CaCO_3$/2H

xxv Fe/2HOH/CO /500d $FeCO_3$/4H

$FeCO_3$ /800d FeO/CO_2
$2FeCO_3$/CaC_2 /1000d $CaCO_3$/2Fe/3CO

xxvi CO/H / -200d CO/H (CO ... remains as liquid.)

xxvii Si/2NaOH/HOH//CaO - Na_2SiO_3/4H (lime catalyst)

xxviii "Hydrogenite mixture of FeSix, NaOH, and $Ca(OH)_2$ in ratio of 25 : 60 : 20 /t Na, Ca, SiO_3/H

xxix Na/HSH - NaSH/H

xxx C/HOH /it CO_2/4H

xxxii 2CrO/6H : $3SO_4$ - 2Cr : $3SO_4$/2H

This might have been written :—
xxxiii 2CrO/$3H_2SO_4$/Aq - $Cr_2(SO_4)_3$/Aq/2H

but obviously written as at first ionically much more is expressed than by simply giving formulæ. There the presence of water is understood by the ionising symbol : .

xxxiv 6Mo : 12Cl/18H : 18OH /it $6Mo(OH)_3$ 12H : 12Cl/6H,

12H : 12Cl/12Na;12OH - 12NaCl/12H : 12OH

Obviously the HCl is led into caustic soda, and sodium chloride deposited, not being anything so soluble as the soda.

xxxv (n atm(2H/Zn : SO_4 - 2H : SO_4/Zn))

This means that under a pressure of n atmospheres a solution of zinc sulphate yields the metal in favour of hydrogen.

OXYGEN.

i Na_2O_2/HOH - 2NaOH/2O, also alkali peroxides.

ii Na_2O_2/$CaOCl_2$/HOH - $Ca(OH)_2$/2NaCl/2O

iii $3MnO_2$ /rt Mn_3O_4/2O

iv Pb_3O_4 /rt 3PbO/O

v Ag_2O /rt 2Ag/O

vi $KClO_3$//MnO_2 /t KCl/3O

vii $2MnO_2$/$2H_2SO_4$ /t $2MnSO_4$/2HOH/2O

viii $2KMnO_4$/8H : $4SO_4$ 50/d 2KH : $2SO_4$/2Mn : $2SO_4$/3HOH/5O ...

This is a very easy way of preparing oxygen. The acid is dilute as shown. The water produced assists in the solution of the salts produced. Some evaporates and is therefore not shown ionised, for as such it will tend to precipitate $Mn(OH)_2$.

ix 2K : Cr_2O_7/10H : $5SO_4$//Aq /t 2KH : $2SO_4$/2Cr : $3SO_4$/4HOH/3O

xii MnO_2/Na_2O/$2H_2SO_4$ /t Na_2SO_4/$MnSO_4$/3O

xiii $2K_2Cr_2O_7$/$10H_2SO_4$/$3H_2O_2$ - $4KHSO_4$/$2Cr_2(SO_4)_3$/11HOH/9O

xiv BaO_2/$2NH_4Cl$ /t $BaCl_2$/HOH/$2NH_3$/2O

xv CaO/2Cl - $CaCl_2$/O, also BaO

xvi $CaOCl_2$ /rt $CaCl_2$/O

xvii $CaOCl_2$//Mn, Fe, Co, Ni, Cu, oxide /t $CaCl_2$/O

xviii PbO/2Cl - $PbCl_2$/O, also CdO

xix NaOH/2Cl /t NaCl/HCl/O

xx NaOH/2Br /t NaBr/HBr/O

xxi $Ca(OH)_2$/4Cl /t $CaCl_2$/2HCl/2O, also Br

xxii $4CuCl/2O//.HOH$ – $2Cu_2OCl_2$ (moist air)

$2Cu_2OCl_2$ /drt $4CuCl/O$ (dull red heat)

This is a means of getting oxygen from the air.

xxiii $CaSO_4/SiO_2$ /t $CaSiO_3/SO_2/O$

xxiv $2CaCO_3/PbO/O//.HOH$ /t $Ca_2PbO_4/2CO_2$
$Ca_2PbO_4/2NaCO_3/2HOH$ – $2CaCO_3/4NaOH/PbO_2$
PbO_2 /500d PbO/O

xxv $2CuO$ /t Cu_2O/O
Cu_2O/O /-t $2CuO$ (whilst cooling)

xxvi $4NaNO_3/2ZnO//Air$ /t $2Na_2ZnO_2/4N/10O$

HYDRIC ACID.

Water enters into more reactions than any other liquid, giving hydrogen with metals, hydrochloric, nitric, and a host of other acids with the corresponding salts, and producing its salts known for a great number of years as hydrates.

i Li/HOH – $LiOH$, also alkali anl alkaline earth metals, Be, .Al, and a number of other metals finely divided and heated.

ii $Mg/2HOH$ /100d $Mg(OH)_2/2H$

iii $MgSi/2HOH$ /t $Mg(OH_2/2H$

iv $CaH_2/2HOH$ – $Ca(OH)_2/4H$, also SrH_2, BaH_2

v Be : 2Cl/2H : 2OH n/- Be(OH$_2$ /2H : 2Cl, also $BeBr_2$, BeI_2

vi $MgCl_2/HOH$ /500d $MgO/2HCl$

vii CuF_2/HOH /500d $MgO/2HCl$

viii CuF/HOH /t $CuO/HF/O$

ix $2AgF/HOH$ /bp $Ag_2O/2HF$

x Hg_2F_2/HOH – $Hg_2O/2HF$

xi HgF_2/HOH – $HgO/2HF$ (reaction complete)

xii $2CuF_2$ /1000d $2CuF/2F$ but in air
CuF_2 /700d $CuO/2HF$

xiii $AuCl_3/AgF/3HOH$ – $AgCl/Au(OH)_3/3HF$

xiv $ZnCl_2/HOH$ – $ZnOHCl/HCl$

xv $CaCl_2/2HOH$ O/t

xvi $4BF_3/2HOH$ – $HBO_2/3HBF_4$
$4BF_3/3HOH$ – $B(OH)_3/3HBF_4$

xvii $4BCl_3/3HOH$ – $B(OH)_3/3HBCl_4$

xviii $4BBr_3/3HOH$ – $B(OH)_3/3HBBr_4$

xix $BI_3/3HOH$ – $B(OH)_3/3HI$

xx $BBr_2I/3HOH$ – $B(OH)_3/2HBr/HI$

xxi $2AlCl_3/3HOH$ – $Al_2O_3/6HCl$

xxii $2ScCl_3/3HOH$ – $Sc_2O_3/6HCl$ also Ga, Y, La, only %

xxiii $3InCl_3/xHOH$ – $2InCl_2/In/xHOH$

xxiv $3InCl/HOH$ – $InCl_3/2In$

xxv $CeCl_3/HOH$ /t $CeOCl/2HCl$

xxvi $2TlCl_3(NH_3)_3/3HOH$ – $Tl_2O_3/6NH_4Cl$

xxvii $NaAlO_2/2HOH$ /t $Al(OH)_3/NaOH$, also K salt

xxviii $COCl_2/2HOH$ – $CO(OH)_2/2HCl$

xxix $CCl_4/2HOH$ /t $CO_2/4HCl$

xxx $C_3N_3Cl_3/3HOH$ – $(CNOH)_3/3HCl$

xxxi $SiF_4/4HOH$ – $Si(OH)_4/4HF$
$SiF_4/2HF$ – H_2SiF_6

xxxii $SiCl_4/4HOH$ /-t $Si(OH)_4/4HCl$, also $SiBr_4$, SiI_4

xxxiii $SiHCl_3/4HOH$ – $Si(OH)_4/3HCl/2Cl$

xxxiv $C_2Cl_6/4HOH$ – $2CO_2/6HCl/2H$, also Si_2Cl_6, Si_2Br_6, Si_2I_6

xxxv $TiF_4/4HOH$ – $Ti(OH)_4/4HF$ to form H_2TiF_6

xxxvii Also bromide and iodide with decomposition of HI

xxxviii $ZrF_4/4HOH$ /t $Zr(OH)_4/4HF$. The hydrate combines with ZrF_4

xxxix $ZrCl_4/2HOH$ /t $Zr(OH)_2Cl_2/2HCl$, also $ZrBr_4$, ZrI_4

xl $GeF_4/4HOH$ - $Ge(OH)_4/4HF$, also $GeCl_4$, $GeBr_4$, GeI_4

xli $SnF_4/4HOH$ - $Sn(OH)\ /4HF$, also $SnCl_4$, $SnBr_4$, SnI_4
SnO_2 also formed and H_2SnCl_6 and H_2SnBr_6

xlii $PbF_4/2HOH$ $PbO_2/4HF$, also $PbCl_4$ to form $PbCl_2$, Pb_2OCl_2, Cl, and oxides.

xliii $ThF_4/4HOH$ $Th(OH)_4/4HF$, also $ThCl_4$, $ThBr_4$ ThI_4

xliv $2PF_6/5HOH$ $P_2O_5/10HF$, also PCl_5, PBr_5

xlv $2PF_3/3HOH$ $P_2O_3/6HF$, also PCl_3, PBr_3, PI_3

xlvi $P_2Cl_4/4HOH$ $P_2O_4/4H/4HCl$, also P_2I_4.

xlvii $2POF_3/3HOH$ $P_2O_5/6HF$, also $POCl_3$,$POBr_3$

xlviii $2POCl/HOH$ - $P_2O_3/12HCl$

xlix $2VF_3/4HOH$ /t $V_2O_3HOH/6HF$

l $2VCl_4/O/4HOH$ - $V_2O_5/8HCl$

li $2VBr_3/O_2/3HOH$ - $V_2O_5/6HBr$

lii $2VOCl_3/3HOH$ - $V_2O_5/6HCl$

liii $2AsF_3/3HOH$ n/- $As_2O_3/6HF$, also $AsCl_3$, $AsBr_3$, AsI_3

liv $2AsF_5/5HOH$ - $As_2O_5/10HF$, also $AsCl_5$

lv $2CbF_5/5HOH$ /t $Cb_2O_5/10HF$, also $CbCl_5$

lvi $2CbOCl_3/3HOH$ - $Cb_2O_5/6HCl$, also $CbOBr_3$

lvii $SbCl_3/HOH$ - $SbOCl/2HCl$, also $SbBr_3$

lviii $4SbI_3/5HOH$ - $Sb_2O_3Sb_2O_2I_2/10HI$

lix $4SbF_3/3HOH$ - $Sb_2O_32SbF_3/6HF$

lx $4SbF_5/3HOH$ - $3SbOF_3SbF_5/6HF$

lxi $SbCl_5/2HOH$ - $SbO_2Cl/4HCl$

lxii $SbSCl_3/HOH$ - $SbOCl/S/2HCl$

lxiii BiF_33HF/HOH /t $BiOF/5HF$

lxiv $BiCl_3/HOH$ - $BiOCl/2HCl$, also $BiBr_3$ BiI_3

lxv $S_2Cl_2/2HOH$ - $SO_2/H_2S/S/2HCl$, also S_2Br_2, S_2I_2

lxvi $SCl_4/2HOH$ - $SO_2/4HCl$

lxvii $SO_2F_2/2HOH$ - $H_2SO_4/2HF$, also SO_2Cl_2

lxviii $SOCl_2/HOH$ - $SO_2/2HCl$

lxix $S_2O_3Cl_4/2HOH$ - $SO_2/SO_3/4HCl$

lxx $CrF_6/3HOH$ - $CrO_3/6HF$

lxxi $CrCl_3/3HOH$ /bp % $Cr(OH)_3/3HCl$ (not complete)

lxxii $SeF_4/2HOH$ - $SeO_2/4HF$, also $SeCl_4$ $SeBr_4$ SeI_4

lxxiii $Se_2Cl_2/2HOH$ - $SeO_2/H_2Se/2HCl$, also Se_2Br_2, Se_2I_2

lxxiv $TeF_6/3HOH$ - $TeO_3/6HF$

lxxv $TeCl_4/2HOH$ - $TeO_2/4HCl$, also $TeBr_4$, TeI_4

lxxvi $2TeCl_2/2HOH$ - $2TeO/4HCl$, also $TeBr_2$, TeI_2

lxxvii $MoF_6/3HOH$ - $MoO_3/6HF$

lxxviii $MoCl_5/2HOH$ - $MoO_2/Cl/4HCl$

lxxix $WF_6/3HOH$ - $WO_3/6HF$, also WCl_3

lxxx WCl_2/HOH - $WO/2HCl$, also WBr_2

lxxxi $WCl_4/2HOH$ - $WO_2/4HCl$, also WBr_4

lxxxii $2WCl_5/5HOH$ n/- $W_2O_5/10HCl$, also WBr_5

lxxxiii $2UCl_5/5HOH$ n/- $U_2O_5/10HCl$

lxxxiv MnF_2/HOH - $MnO/2HF$, also $MnCl_2$

lxxxv $2MnF_3/3HOH$ - $Mn_2O_3/6HF$, also $MnCl_3$

lxxxvi $MnF_4/2HOH$ - $MnO_2/4HF$, also $MnCl_4$, though salts not isolated

lxxxvii $FeCl_3/3HOH$ - $Fe(OH)_3/3HCl$

lxxxviii $2RuCl_3/3HOH$ - $Ru_2O_3/6HCl$

lxxxix $OsF_6/4HOH$ - $H_2OsO_4/6HF$

xc $OsF_8/5HOH$ - $H_2OsO_4/O/8HF$

xci $OsCl_2/HOH$ - $Os/O/2HCl$

xcii $OsCl_4/2HOH$ - $OsO_2/4HCl$, hydrating to OsO_2HOH

British Association for the Advancement of Science.

SECTION I.—PHYSIOLOGY.

FUNCTION AND DESIGN.

ADDRESS BY PROFESSOR J. B. LEATHES, F.R.S.
PRESIDENT OF THE SECTION.

"Among natural sciences physiology takes a place which in one respect is different from that taken by any other. It studies the phenomena of life, but more particularly the ways in which these phenomena are related to the maintenance of life. Anatomy and morphology are concerned with the forms of living organisms and their structure; biological chemistry, as distinct from physiology, with the composition of the material in which the phenomena of life are exhibited. The province of physiology, in studying the functions of these forms and of this material, is to ascertain the contributions that they make to the organisation of the living mechanism, and learn how they minister to the maintenance of its life. Function implies ministration, structure for physiology implies adaptation to function, what in a word may be termed design.

Ultimate analysis of the phenomena with which physiology deals leads to the fundamental distinction between matter in which life is manifested and matter in which it is not. Life is exhibited only in aqueous systems, containing unstable, perishable combinations of carbon with hydrogen, nitrogen, sulphur, phosphorus and oxygen, in the presence of certain inorganic ions, those which are present in the set, the native environment originally of all forms of life; and the inalienable property that such matter exhibits when alive, and that matter which is not alive does not, is that these unstable oranic combinations are for ever reforming themselves out of simpler combinations that do not exhibit this property, and do so at a rate which averages at least not less than that at which they break down. This power of self-reformation, spontaneous regeneration, operates not only when living organisms cells or communities of cells are growing or reproducing their kind; the very maintenance of living existence requires by definition that it should persist. In the absence of water the living process may sometimes apparently be suspended for a time, as it may be if the surrounding watery medium is immobilised by cold; it is a question how long such suspended animation is possible where it is possible at all. It is only where water has the kinetic activity of the liquid state that spontaneous regeneration of living matter can in general proceed, and then it must, for when it ceases the unstable material ceases to live.

Chemical analogies for this power of spontaneous regeneration, if such exist, can only exist in part; in the present state of our comprehension of it, certainly, it is hazardous to try to trace them. The attempt so commonly made to trace one between the growth of living matter and the growth of crystals in a saturated solution, it is safe to say, is in so many respects on the wrong lines that it is merely misleading. Crystals are not alive. The molecules that constitute the crystal are set in solid formation; so long as the crystal exists they are stable and unchangeable. These molecules collect on the growing crystal, but they exist ready-made in the surrounding solution; they do not come into being by the influence of the crystal; they are themselves so constituted as to take up a set position in relation to each other and to those already ranged side by side in the crystal, as soldiers on the drilling-ground at the word 'fall-in'; they are available because the solution is kept saturated by the dissolving of smaller but similar crystals that for physical reasons are more soluble in the solution than the larger ones. In contradistinction to this, the molecules that enter into the composition of living matter exhibit the phenomena of life only when permeated with water molecules exercising the kinetic activity of the liquid state; they are unstable and

perishable; the added molecules, some of which even during growth and all of them at other times, serve but to replace those that perish, do not exist ready-made; they come into being only in conformity to the pattern and under the influence of those already in existence, a pattern that these alone can use; and they are formed out of material that is chemically different from them.

Let us for a moment consider what this spontaneous regeneration implies. Of the various chemical components of protoplasm proteins are generally considered the most important, often the only important, ones. The elucidation of the chemical principles upon which the structure of proteins rests, which took place about the beginning of this century, was, like the neurone hypothesis of the structure of the nervous system, an advance the magnitude of which only those perhaps can appreciate who began the study of physiology well back in an earlier one. For a time it seemed in each case that the problem was solved and all that was to follow was simple. Those were great days. The best-known varieties of proteins, when detached and uprooted from the place where they grew, consist of chains of about a hundred, sometimes nearly two hundred, links. Each link is an amino acid coupled by its acid group to the amino group of one neighbour and by its amino group to the acid group of its other neighbour, a molecule of water being lost at each linkage. There are not more than about twenty different amino acids, so that some of them must occur several times in the chain; in some kinds of protein one amino acid may occupy thirty or forty of the hnndred places in the chain. In any such isolated protein it is probable that the order as well as the proportion in which each amino acid occurs in the molecule is fixed, and it is this specific order and proportion that accounts for the specific character and properties of the protein. What could be simpler? And only yesterday all was so obscure.

It is not recorded that in the rush of this advance anyone stopped to reflect what number of formations such a protein might still possibly have. Supposing it were a chain of only fifty links, a very simple case; if all the links were different the number of possible permutations is denoted by the innocent-looking symbol $|\underline{50}$. If, instead of all being different, one kind of link recurred ten times, the number would be reduced to $|\underline{50} / |\underline{10}$. If, in addition, there were four that recurred four times and ten that recurred twice, it would be further reduced to

$$|\underline{50} / |\underline{10} \times (|\underline{4})^4 \times (|\underline{2})^{10}.$$

It would now consist of a chain of only fifty links, of which there were only nineteen different kinds, and the number of different arrangements of its parts would be about 10^{48}. Astronomy deals with big figures. Light, it is said, takes 300,000 years to travel from one end of the Milky Way to the other; this distance expressed in Angstrom units, 10,000,000 of which go to a milimetre, would be less than 10^{32}. So far are we from knowing the structure of protein molecules. So far are we from knowing what variations in disposition of the parts in such a molecule may not occur witrout our being within a measurable distance of detecting them. For if the number of possible varieties of a protein whose molecular weight is known, and known to be exceptionally small, and which contains the several amino acids in a known proportion, is as great as this, the number that is possible when that proportion may be changed is practically incalculable, each change in proportion being capable of a number of new arrangements that could be calculated, as was done for our hypothetical case.

But in the living cell where these chains are put together each link must first be fashioned and then forged into the chain; unfinished chains *in statu nascendi* must exist which our analytical methods can never detect. In such unfinished chains the order presumably in which the amino acids are linked up is observed, but the proportion must be different from that in the finished product; for in a chain of nearly a hundred links a particular amino acid, cystine, for instance, may occur only once.

Now it is possible that the analogy of crystal formation may be applied to the reproduction of the characteristic order in which the linkings occur, and that the parts out of which a new chain is to be formed may be collected and brought into position alongside of the corresponding parts of an existing chain by forces that are similar to those that determine the latticed relations of atoms in a crystal. But something more than this is required to account for the linking np of these links by the loss of water, and still more for the fashioning of the links themselves. In plants all varieties of amino acids come into being as required; in animals, it is true, some mnst be supplied ready-made in the medium in whch the proteins grow; but even in animals some of

them can be formed from material of a totally different nature.

Wherever this is the case we have to suppose that it is by selective emphasis of certain otherwise unemphasised but possible arrangements of atoms or groups of atoms, evidence for the occurrence of which under similar conditions in the absence of life is generally not obtainable. Specific catalysed syntheses must co-operate with the forces that merely sort out and place in proper order the assembled parts, and must fashion for them the particular links that they need at each step. Specific catalytic agents playing an important part in cell chemistry are familiar in the enzymes found in digestive secretions and also locked away within the cells themselves. There is much to support the idea that such agents act by modifying the chaotic, indeterminate, kinetic agitation of certain kinds of molecules in their immediate neighbourhood in such a way that the relative positions in space of groups capable of reacting with one another tend to become those in which reaction is likely to occur, and to occur in conformity with a certain pattern. The peculiar thing about the chemistry of living matter is not that the reactions that are characteristic in it are novel, but that in the rough and tumble of ordinary liquid systems their occurrence is almost infinitely improbable. Where there is life circumstances exist which make them the rule. Anyone conversant with work in animal metabolism can supply many illustrations; for instance, it has been shown that in a simple solution of the amino acid alanine traces of methyl glyoxal occur; in the animal body there is reason for thinking the reaction may become practically quantitative. Forces which determine the relative positions of adjacent foreign molecules and so affect their behaviour are something to which there is no analogy in the growth of crystals in a saturated solution.

Moreover, if the forces that determine the reproduction of a certain order in the arrangement of the parts of a protein are similar to those that determine the lattice pattern of a crysal, the crystals with which the comparison is made are solid, and life is manifested only in liquid aqueous systems. The analogy should rather be with the formation of liquid crystals, a phenomenon that is itself as yet too unfamiliar to shed common light on the obscurity of spontaneous regeneration. The ordered disposition of the ultimate components of protoplasmic systems is such as to leave play, generally but little checked, for the fluid properties of water, and in some modified degree too of molecules and ions dissovled in water. Even a solid jelly may include within its protein framework a hundred times its weight of water in which diffusion is free to take place almost as if the framework were not there, and protoplasm, with commonly twenty times as much protein in it as this, more often resembles a fluid of varying viscosity than a solid gel, which means that the great protein chains float and drift in the whirlpool of kinetic agitation, observing, it may be, so far as is possible, certain unstable relations to their kind, but with no rigid fixity. It is commonly felt that the behaviour of unicellular organisms makes the hypothesis necessary that there is an insoluble surface layer that keeps the watery contents of the cell from dispersing in the water that surrounds is. Much experimentation, and no lack of speculation, has not made clear what the nature and structure of this limiting layer is. It may be that the flexible cohesion at many alternative points between clinging floating chains of amino acids, the innermost of which are made fast to the nucleus, may go some way to maintain the identity of the cell and prevent its contents from scattering.

But in the chemical make-up of protoplasm, proteins, the most abundant component, are not the only ones that are necessary. Pre-eminent among the others are the nucleic acids. When we consider what has been learnt of the behaviour and of the chemical composition of the nuclear chromosomes, and that according to Steudel's reckoning the nucleic acids form 40 per cent. of the solid components of these chromosomes ,into which are packed from the beginning all that pre-ordains, if not our fate and fortunes, at least our bodily characteristics down to the colour of our eyelashes, it becomes a question whether the virtues of nucleic acids may not rival those of amino acid chains in their vital importance. From Steudel's figures it can be reckoned that there are about half a million molecules of nucleic acid in a single sperm cell of the species with which he was working.

But in addition to nucleic acids there are also strange compounds of higher fatty acids containing suspiciously significant groups, identical in their general character with those found also in nucleic acid, namely, phosphoric acid, organic bases and sugar;

and besides these there are the mysterious sterols. All of these are frankly insoluble in water, and yet have in some part of their composition features that make them not indifferent to water or even to the molecules and ions that exist in true solution, in the liquid state, within the cell. The physical condition of these insoluble substances in the aqueous system of the cell is still little understood. All that can be said with certainty is that they must modify its homogeneity even more than the long floating chains of amino acids, however much these may be liked together one with another. If the characteristic behaviour of living matter is rightly regarded as due to the order that it introduces into the movements and spatial relationships of foreign molecules in its vicinity, then these insoluble components may well be expected to play a leading role by forming films and surfaces that permeate its texture and delimit its parts.

Such an analysis of the chemical meaning of material life viewed in the light of scientific facts has to be largely an exercise of the imagination, but it may present itself as an intellectual necessity. If it is right to regard the power of spontaneous self-regeneration as the distinctive property of living matter, it is not intellectually possible to be content with a phrase and dismiss it. A phrase is itself an image, and an image, however however shadowy, has parts and dimensions. Those who feel it an intellectual necessity to explore unexplored lands cannot procure maps, but that does not justify their setting out with no forethought or reasoned plans.

The beginning of life, if it is an intellectual necessity to trace this, would thus appear to have been in the coming together of atoms of certain elements in such a pattern that this power in its simplest form resulted from its design. Some might call this event fortuitous, others the predictable outcome of the inherent properties of those elements, the inevitable operation in the course of time of the laws of chance. Those who call it fortuitous may go so far as to regard the whole history of life as fortuitous, and give priority to the concurrence of the atoms over the properties and functions that are revealed by the concurrence. The others may look on life as the fulfilment of the destiny of these elements, and give priority to the potential properties of matter over the concurrence which was no more than their epiphany.

If this analysis is approved and the distinctive property of living matter, the power of self-regeneration, depends upon the power of limiting the movements and directing and controlling the spatial relations of surrounding molecules so as to modify their chemical behaviour, it is the exercise of this same power that leads to the formation of substances such as starch, glycogen and fats; and in so far as such substances contribute to the regeneration of the living matter, the power of forming them contributes to its survival. Where energy is necessary for such synthetic rearrangements of adjacent matter—where, that is, the rearrangement involves coercion of atoms into positions of strain in which they have the potential energy of position which we call chemical energy—this energy may be derived from the radiant energy of the sun or from the combination of oxygen with adjacent organic matter. In the latter case the combination is again a manifestation of the power of ordering the disposition of surrounding molecules and directing their movements so that they behave as in other circumstances they would be but little prone to do. The energy so liberated, besides contributing to the formation of new living matter or of the material to be used in its formation, may serve in other ways to promote the processes by which life is maintained. It may accelerate them by imparting increased kinetic activity or rise of temperature, or may bring about movements that are resisted by external forces, and so enable the living system to do work.

This is all merely a restatement of the commonplaces of biology, necessary only as part of the attempt to correlate them physiologically with the fundamental property of that which is alive to regenerate itself at the expense of material that is not alive. This faculty implies the power of introducing order into the chaotic movements of adjacent matter in conformity with patterns that it possesses. It is a faculty resident in material that is capable of incalculable variation. The number of permutations of its parts that are possible without affecting the results of such analysis as is practicable defies calculation. Their calculation, were it possible, would lead to figures that are so large as to mean no more than the dimensions of the universe. Some of these permutations confer synthetic powers which others do not. When they appear, are they not what biologists call for short mutations? But when they appear, if they retain the

power of self-regeneration, and if they minister to its maintenance, they will *ipso facto* survive. For whatever promotes persistence of this power must itself survive.

A disposition of matter in molecules or aggregates, unstable and incalculably variable, that has and retains the power of determining the disposition of matter not yet so disposed in such a way as to conform to its own disposition or to patterns which help it to exercise this power, is all that must be premised for the whole of evolution to follow. Variations that do not or cease to contribute to the retention of this power do not survive. The condition of survival is ministration to self-regeneration, that is to the maintenance of life."

(To be Continued Next Week.)

General Notes.

THE NEW ATOMIC HYDROGEN FLAME.

At the annual meeting of the American Chemical Society on September 9, Dr. Irving Langmuir, an authority on the structure of the atom, declared that the discovery of the new atomic hydrogen flame process had opened up a new "age of alloys." With the heat of 8,000-9,000 deg. Fahrenheit now obtained it was possible to weld combinations of metals, which had hitherto resisted all efforts to fuse them, making stronger and more ductile alloys than had ever been made before. The process involved a dissociation of hydrogen molecules into atoms by the use of powerful electric arcs between tungsten electrodes, bathed in a gentle stream of hydrogen from a ring of nozzles surrounding the electrodes.

CITY OF CARDIFF EDUCATION COMMITTEE.

The syllabus for the season 1926-27 has been issued, and the joint course with the University College of South Wales and Swansea, especially the course in Chemistry and Associated Subjects, will have particular interest for our readers. Particulars of the various subjects, the open scholarships, etc., will be found on our front page.

A MEMORIAL TO "OLD BOYS."

The Governors of Ellesmere College, Shropshire, have decided to proceed with the building of the Memorial Chapel at this well-known Public School. The Chapel is intended as a Memorial to all old Ellesmerians and especially those who fell in the War of 1914 to 1918, and it has been designed on broad lines by Sir Aston Webb, the famous architect, to accord with the present School Buildings. The Ceremony of laying the Foundation Stone by Sir Offley Wakeman, Bart., the Custos of the College, has been arranged for September 30 (with a preliminary Festal Service for St. Oswald, the Patron Saint of the College, on the previous evening), and a number of Church dignitaries, including the Bishop of Lichfield, will be present and officiate at the actual laying of the stone. The Governors appeal to all old Ellesmerians to be present at the Ceremony, not only as a tribute to their old School, but to say "Vale" to the Rev. T. H. Heaworth, M.A., the present Headmaster, who is retiring after a lengthy and useful service to the cause of education. Full details will be gladly supplied by the Secretary, Ellesmere College, Shropshire, and contributions to the Building Fund acknowledged.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH.

Professor Vernon Herbert Blackman, Sc.D., F.R.S.; Professor Frederick George Donnan, C.B.E., D.Sc., LL.D., F.R.S.; and Professor Frederick Alexander Lindemann, Ph.D., F.R.S., have been appointed by Order of Council dated 20 August, 1926, to be members of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research, in the place of members who have retired on the completion of their terms of office.

CANADIAN MINING NOTES.
COBALT.

Finally revised statistics on Canada's cobalt production show the output of this metal to be 1,116,492 pounds, valued at $2,328,517 during 1925, as against 948,704 pounds, valued at $1,682,395 in 1924, according to a report just issued by the Mining, Metallurgical and Chemical Branch of the Dominion Bureau of Statistics at Ottawa.

ARSENIC, COPPER AND NICKEL IN CANADA IN 1925.

ARSENIC.

Finally revised statistics on the production of arsenic from Canadian ores as reported by the Mining, Metallurgical and Chemical Branch of the Dominion Bureau of Statistics show an output of 3,434,137 pounds in 1925 as compared with 4,621,567 in 1924.

Arsenic in large quantities is consumed in the manufacture of calcium arsenate, an insecticide which is most effective in combating the boll-weevil.

In Canada, arsenic is used in the manufacture of Paris green, lead arsenate, lime arsenate, sheep dips and other insecticides. Other uses are in the manufacture of glass and to a small extent in medicinal and pharmaceutical preparations.

Arsenic is recovered from the concentrates of the arsenical pyritic ore of the Nickel Plate Mine, Headley, B.C., which are exported from Canada to be treated in foreign smelters.

White arsenic is produced in Canada by the South Ontario smelters in the treatment of ores and residues from the Cobalt camp.

COPPER.

Finally revised statistics on the output of copper in Canada as reported by the Mining, Metallurgical and Chemical Branch of the Dominion Bureau of Statistics at Ottawa show a production in 1925 of 111,450,518 pounds, which at the average New York price for the year (14.042 cents per pound), amounted to $15,649,882, as compared with 104,457,447 pounds valued at $13,604,538 in 1924.

NICKEL.

Finally revised statistics on nickel production in Canada during 1925 as reported by the Mining, Metallurgical and Chemical Branch of the Dominion Bureau of Statistics show an output of 73,857,114 pounds of nickel, valued at $15,946,672, as compared with 61,356,451 pounds, worth $12,126,739 in 1924.

CHEMISTRY OPENING A NEW ERA FOR MANKIND.

The American Chemical Society opened its conference at Philadelphia on September 8 under the presidency of Dr. J. F. Norris, who, in his presidential address, predicted the coming of a new era of wonderful discoveries, among them a new liquid for motive power, and the manufacture of food synthetically.

The use of heat as a form of energy began the first great epoch of man's mastery of nature; the use of electricity the second. Already, said Dr. Norris, results leading to discoveries of great usefulness had been secured through the employment of radiant energy, which would ultimately be obtained free and in unlimited amounts. He cited as an example the laboratory production of methane, the chief constituent of natural gas. It had been made from carbon and hydrogen with the use of radium. Obtaining methane meant producing a supply of combustible liquid with which to run motor cars when supplies of petroleum were exhausted.

He said that the discovery that ultra-violet rays would convert formaldehyde into sugar made it possible to see that foods in the future would be produced by synthesis, without the slow process of passing through the vegetable kingdom. That was only one of the many benefits which the new chemistry was destined to supply to man. He foresaw that in the next half-century knowledge of matter would be extended so broadly that what the world knew to-day would be but the foreground of an impressive picture.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE FARADAY SOCIETY.

June 14, 1926.

Explosive Reactions Considered in Reference to Internal Combustion Engines. By SIR DUGALD CLERK, K.B.E., D.Sc., F.R.S.

The working fluid of all internal combustion engines near the end of the stroke consists of steam, carbon dioxide, nitrogen and oxygen. At that point the combustion of the gaseous mixture is practically complete, but the reactions proceeding during the initial spread of flame in gas engines and injection of burning oil spray in most oil engines are very complex and are not yet thoroughly investigated. To develop the theory of those motors it is necessary to obtain more accurate values as to dissociation, continued combustion and heat loss during initial combustion and expansion by

convection and radiation. The varition of specific heat of the gasese between 0° and 2000° C. also requires further work.

Considerable progress has been made by the late Professor Bertram Hopkinson, Professor Harold Dixon and other members of the British Association Gaseous Explosions Committee, but there is still ample opportunity for the younger men, and I study with singular pleasure the important papers on engine cylinder phenomena by Ricardo, Tizard, Pye and Gibson , and on explosions in closed vessels by Petavel, Bone, Wheeler and Fenning.

The hot air engine was the forerunner of the internal combustion motor, and its theory was developed by McQuorn Rankine, Joule and Thompson before 1850. Air was considered to have constant specific heat at all working temperatures, and on this assumption the Joule air engine, which would now be called a constant pressure engine, was shown to have an ideal efficiency where U = indicated work, H_1 the total heat received, and r = the ratio of compression and expansion of

$$\frac{H_1}{U} = 1 \quad \left(\frac{1}{r}\right)^{0 \cdot 408}$$

This appears to be the first instance of the recognition of a cycle of operations of constant efficiency; that is, constant for all maximum temperatures. This expression has been shown to apply to the three existing cycles of internal combustion engines (assuming air as the working fluid)—constant pressure, constant -volume and con stant volume or Carnot cycle. In all three the ideal efficiency is given by the well-know expression $E = \left(\frac{1}{r}\right)^{\gamma - 1}$. The constant pressure and constant volume cycles are imperfect, but the efficiency is determined by the formula taking into account only the compression ratios, and it is remarkable that it also applies to the perfect Carnot cycle. Its efficiency is also determined by the compression ratio.

A UNICONTROL HIGH-FREQUENCY RADIO DIRECTION FINDER.

By F. W. Dunmore.

(*U.S.A. Bureau of Standards.*)

Abstract.

The Bureau of Standards was asked to develop for the United States Coast Guard a simple type of radio direction finder which should function on 2,100 kc (143 m.). Such a device enables a ship equipped with it to locate another ship readily. This paper describes the development of such a direction-finder and its installation on a Coast Guard patrol boat. The direction-finder coil consists of four turns of ignition cable wound on a 20-inch frame. It is installed over the pilot house and rotated from below. A tuning unit and coupling transformer have been designed so that the direction-finder coil may be used on the ship's receiving set without changing its tuning adjustments, which are locked in the 2,100 kc. position. A special form of automatic balancing condenser operated by a special cam rotating with the direction-finder shaft is incorporated in this instrument whereby a clear minimum may be obtained at all angular positions of the coil without manual operation of the balancing condenser. The controls necessary when taking a bearing are thus reduced to one—that of rotating the direction-finder to obtain the minimum signal.

Conclusion.

The type of direction-finder as described, while operating at a radio-frequency higher than has been customary for direction-finding purposes, has proven to be a satisfactory device on a small type of boat, such as the Coast Guard patrol boat. While tests have not been made to determine its efficacy on a larger shup, it is thought that such use may be possible if care is taken to prevent the natural frequency of stays, guys, antennas, etc., from approaching that of the radio-frequency used for direction finding.

It is expected that errors due to radio wave transmission phenomena will be more pronounced when working over long distances on high frequencies than with the lower frequencies commonly used. The errors due to transmission phenomena are not great over short distances, therefore do not seriously affect the accuracy of the direction-finder, which will generally be used in this service to take the bearing of a near-by vessel in order to proceed to it.

NOTES ON THE PREPARATION OF STANDARD CELLULOSE.

By A. B. Corey and H. Le B. Gray.

(*Eastman Kodak Company Publication.*)

While preparing standard cellulose in this laboratory according to the method given in the report of the Committee of the

Division of Cellulose Chemistry of the American Chemical Society, Professor Hibbert suggested that we offer a criticism of the method as given, for the purpose of promoting a discussion which might lead to an improvement in the standard obtained.

In the procedure as given by the committee it is recommended that 100 grams of cotton be put " loosely " in a nickel-screen container and boiler in three litres of solution. A container of a size to permit total immersion in 3 litres of solution, with allowance for the vertical motion, is too small to allow 100 grams of cotton to have the freedom of motion which the writers believe it ought to have. They therefore recommend that the amount of solution be increased, thus making possible the use of a container of such a size as will allow the cotton to move freely about in it.

Simonsen, working on easy bleaching Scandinavian sulfite pulp, found that bleached cellulose is very considerably attacked by bleach solutions, especially in the concentrated form. This would lead to the view that the bleach solution causes a pronounced change in the cellulose. It is a well-known fact that bleach tends to oxidise cellulose. Therefore, it would seem advisable to omit bleach if possible.

Several samples of cotton were purified according to the American Chemical Society method and compared with samples which had been prepared by modifying the procedure. Every sample which was bleached during the purification gave an α-cellulose yield of less than 99 per cent. and a copper number of about 0.7. By omitting the bleaching operation a product could be obtained which was 99.8 per cent. α-cellulose and had a copper number of 0.2. It also seemed advantageous to use a 1 per cent. algali extraction in place of the rosin soap treatment, in case the cotton had been extracted previously with alcohol and with ether to remove waxes, etc.

The following is offered tentatively for consideration and criticism. One hundred grams of carefully picked Wannamaker's Cleveland are extracted in a Soxhlet for six hours with 95 per cent. ethyl alcohol, at such a rate that the alcohol is siphoned every 30 minutes. It is then extracted with ether for 6 hours, the liquid changing every 30 minutes.

After the extraction the cotton is placed in the nickel-screen basket and treated with 3 litres of a one per cent. sodium hydroxide solution which has been previously boiled to remove air. It is boiled for six hours, during which time 3 litres of fresh 1 per cent sodium hydroxide solution are run in. This is accomplished by having a flask containing the solution, which is maintained at the boiling point, at such a level that the liquid may be siphoned into the beaker containing the cotton. The fresh solntion enters at the bottom of the beaker while the old solution is removed from the top by a constant-level overflow. The rate of flow is regulated so that it takes six hours for the fresh solution to flow in. By this method the products extracted by the solution are continually removed. When the solution in the flask is nearly gone, a small portion of distilled water that has been previously boiled is added. This is repeated several times and the flask is then filled with distilled water (previously boiled), and the cotton washed in this manner. Water is continually added in this way until the cotton is thoroughly washed. Thus duriug the period of treatment and washing, the cellulose is not exposed to the air. The cellulose is then drained and removed from the container. It is washed in three changes of distilled water, which is sucked off each time on a Büchner funnel and the cellulose then air-dried.

During the course of the work it was noticed that the cellulose which had been bleached always imparted to the solution a bright lemon-yellow colour when it was treated with 17.5 per cent. sodium hydroxide solution in the cellulose determination, while the unbleached did not. The lemon-yellow colour appears to be due to the presence of cellulose which has been oxidised.

While the writers realise that working with such a compound as cellulose a sufficient number of samples have not be treated and analysed to offer rigorous proof of their results, they feel that the results indicate very strongly that the use of bleach in the preparation of a standard cellulose is very harmful.

BRITISH ASSOCIATION.

Abstracts.

The Hygroscopic Relations of Colloidal Fibres, with Special Reference to their Industrial Importance. By Dr. S. G. Barker, Mr. A. T. King, and Mr. H. R. Hirst.

The theory of elasticity of colloidal fibres is developed, and it is shown that wool

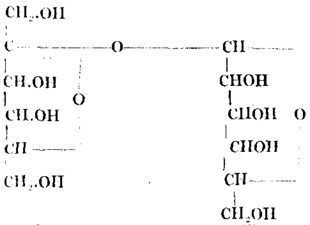
fibres follow the usual characteristics of colloids. There is apparently an elastic framework filled with a viscous medium. The effect of moisture absorption on the viscous phase is discussed, and it is found that wool is a perfectly elastic material and makes a complete recovery from strain even up to its breaking point. The effect of moisture on thermal and electrical conductivity is discussed. In the former case it is shown that the increase in thermal conductivity of any material for an increase of moisture content of 1 per cent. of the dry weight ranges from 1.7 to 2.0 × 101[6] for wool.

The electrical conductivity is shown to increase with moisture content, and it is noted that dry fibres are non-conducting. A table of results is given. Section II treats of the variation of density, swelling and heat of wetting of wool and from the results a theory of wool structure is put forward. Tables are given for density measurements and heat evolved upon wetting at various humidities.

Section III deals with technical applications of the problem, and mentions, *inter alia*, setting of wool, finishing processes and the effect of humidity on the fading of dyestuffs on woollen fibres. The influence of moisture content on the production of bacteria is discussed.

Modern Views on the Structure of the Disaccharides. By PROF. W. N. HAWORTH.

A marked advance made in the constitutional study of sugars is the generalisation that the aldoses normally occur as amylene-oxide forms; that is, having a heterocyclic six-membered ring and not as was formerly thought a five-membered ring (butylene-oxide), and further that the γ-aldoses are butylene-oxide sugars. (*A revision of the* structural formula of glucose: Charlton, Haworth and Peat, *J. Chem. Soc.*, 1926, 89; *cf.* Hirst, *ibid.*, 352). Difficulty was experienced in including the ketoses in this classification owing to oxidation results obtained with fructose derivatives, which pointed to the converse rule. Recent experiments (Hirst and Haworth) indicate, however, that the structure given to normal fructose by Irvine is invalid, as is also that applied to γ-fructose derivatives by Haworth. Both normal and γ-fructose are now included in the generalisation already applied to the aldoses. This fundamental advance involves a large readjustment of our ideas as to the formulæ of disaccharides and polysaccharides. The possibility of the occurrence of γ- or butylene-oxide residues in the disaccharides was first suggested in the above paper by Charlton, Haworth and Peat. The structural formulæ applied to lactose, cellobiose, and maltose admit of this formulation, as also sucrose, raffinose, and inulin. The most satisfactory formula which can be allocated on these principles to sucrose is the following:—



Fructose residue — Glucose residue

NOTICES OF BOOKS.

The current issue of *Chemisch Weekblad* is one that will be read as much outside Holland as inside, for it contains important articles upon the Principles of the Phase Theory. *A number of these contributions* are in languages other than Dutch. Thus, Professor H. Le Chatelier writes in French under the title "L'Oeuvre de J. Willard Gibbs, J. H. L. Vogt"; Prof W. Ostwald and Prof. Tammann write in German; and W. Lash Miller's "The Fundamental Equation of Willard Gibbs" and Professor Donnan's "The Phase Rule of Gibbs in Industry" are in English. Professor Van der Waals, Professor Schreinemakers, Professor van Laar, Dr. Terwen also contribute to the subject and there is an introduction by Prof. W. P. Jorissen. Dr. Freeth writes in English on the scientific work of Prof. Schreinemakers.

International Review of the Science and Practice of Agriculture. April-June, 1926, No. 2, Vol. IV., New Series, International Institute of Agriculture, Rome.

In addition to the numerous contributions and notes of special interest to agriculturists, there are contained in this issue several scientific article which will be read with interest by scientific men and others.

New Patents

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

21,346.—Negle, A.—Apparatus for production of nitric oxide from oxonised air. August 30th.

21,543.—Pease, E. L.—Extraction of ammonia from coal-gas, etc. September 1st.

Specifications Published.

257,353.—British Dyestuffs Corporation, Ltd., Perkin, W. H., and Hollins, C.—Manufacture of new anthraquinone dyestuffs possessing affinity for acetyl silk.

257,361.—Cassella & Co., Ges. L.—Manufacture of new arsenic compounds of the aromatic series.

257,434.—Metal Research Corporation.—Manufacture of hydrogen.

257,470.—I. G. Farbenindustrie Akt-Ges.—Manufacture of chromates.

248,404.—Dupont, G. H., & Brus, G.—Manufacture of synthetic camphor.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

LONITOL.

469,825.—A chemical powder for use in repairing leaky radiators and other Chemisch Pharmazeutische Fabrik, Neue Grunstrasse 4, Berlin, C.19., Germany. September 8th.

" FLORAVITE."

471,211.—A chemical compound in solid or liquid form for preserving and prolonging the bloom of cut flowers.—Alfred Webb, 26, Shaftesbury Avenue, London, W.1. September 8th.

WANTED for Shift Work (8 hours) in Steel Works Laboratory, CHEMIST. Salary, £2 10s. per week. Permanent post if suitable.—Apply, giving age, training and experience, to Box H. S. C. 25, *Chemical News* Office.

SAFETY IN MINES RESEARCH BOARD.

APPOINTMENT.

The Safety in Mines Research Board requires the services of a Chemist for Research Work on the Evaporation Rates and the Ignition Temperatures of Vapours, of certain inflammable spirits used in industry as solvents.

Applicants must possess good scientific qualifications.

Preference will be given to ex-Service men.

Scale of Salary :—£160 : 10 : 190. In addition, a fluctuating cost of living bonus is payable, making the present minimum of the scale £246.

The post is a temporary whole-time one, tenable at Sheffield.

Forms of Application, which must be returned not later than 29th September, can be obtained from the Under Secretary for Mines, Establishment Branch, Mines Department, Dean Stanley Street, London, S.W.1.

BRITISH PATENT 108,853.
IMPROVEMENTS IN EXPLOSIVES.

The Owner of this Patent wishes to grant Licence or to come into relation with someone competent for the Industrial Working of said Patent.

For particulars write to MR. A. VAN DAMME, 7, Rue Du Montenégro, Brussels (Belgium).

UNIVERSITY OF MANCHESTER.
CHEMISTRY COURSES.

A Prospectus containing full particulars of the Lectures and Laboratory Courses qualifying for Degrees in Chemistry will be forwarded on application to the Registrar.

The Session commences on OCTOBER 7TH. Applications for admission to the Research Laboratories should be made to the Director of the Chemical Laboratories.

FRENCHMAN is prepared to give Lessons in French Grammar and Conversation.—Write, " C," c/o *Chemical News*.

THE CHEMICAL NEWS

VOL. CXXXIII. No. 3468.

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THE CONDITIONS UNDERLYING THE FORMATION OF UNSATURATED AND OF CYCLIC COMPOUNDS FROM HALOGENATED OPEN CHAIN DERIVATIVE IN RELATION TO THE ATOMIC VOLUME TETRAHEDRAL THEORY. PART II. PRODUCTS DERIVED FROM α-HALOGENATED ADIPIC ACIDS. HALOGENATED GLUTACONIC ACIDS AND A SYNTHESIS OF THE AROMATIC NUCLEUS.

By R. F. HUNTER, M.Sc., Ph.D., D.I.C., A.R.C.S.

It is well known that the types of carbon ring which occur the most frequently in the natural products are the five and six carbon rings. There is, however, one class of natural products, the essential oils in which many of the compounds contain rings of a more highly strained type and it is observed on examination that the inherent strains due to the presence of cyclopropane and cyclobutane are relieved by the entrance of a gem grouping or some equivalent arrangement in the constitution of the substance. Thus in every case in which there exists in a naturally occurring substance a cyclopropane ring there exists also either an attached gem dimethyl group as in carene or some equivalent quaternary carbon atom as in thujone and sabinene. Where there occurs a substance containing a cyclobutane ring, a gem-dimethyl group is invariably attached to it as in α- and β-pinene. Naturally occuring five membered rings, on the other hand, in some cases carry a gem grouping, and in others do not. Thus, while camphor contains two cyclopentane rings having a gem grouping common to both, camphere possesses two cyclopentane rings, only one of which carries a gem grouping. Finally with regard to the naturally occurring six membered rings of terpene chemistry, not one bears a gem dialkyl group, every cyclic carbon atom in limonene, α-terpineol, sylvestrene and pugelone, α-phellandrene, β-phellandrene and carvone is either secondary or tertiary. These facts are in direct accordance with the modified strain theory (*loc. cit.*).

At this point it is desirable to discuss to some length, the research of Dr. Ingold on the halogenated adipic acids, which is essentially an extension of the work previously discussed (*loc. cit.*). There is a marked difference in properties between the behaviour of halogenated glutaric and halogenated adipic acids to alkaline reagents, for when ethyl α-chloroadipate and ethyl α-bromoadipate are boiled with 2N sodium carbonate a 90% yield of α-hydroxyadipic acid (I.) results; on treatment with methyl alcoholic potash under conditions analogous to those employed with the halogenated glutaric acids, thers is obtained only a trace of the expected cyclobutanedicarboxylic acid (II.), and by far the greatest proportion of the yield consists of the hydroxylation product, there is also obtained a small yield of the unsaturated derivative $\Delta\alpha$-dihydromuconic acid (III.).

$$\begin{array}{l} CH_2.CH(OH).CO_2H \\ \quad | \\ CH_2.CH_2.CO_2H \\ \qquad (I.) \end{array}$$

$$\begin{array}{l} CH : CH.CO_2H \\ \quad | \\ CH_2.CH_2.CO_2H \\ \qquad (II.) \end{array}$$

$$\begin{array}{l} CH_2.CH.CO_2H \\ \quad | \qquad | \\ CH_2.CH_2.CO_2H \\ \qquad (III.) \end{array}$$

The results of Ingold's experiments can be tabulated as follows :—

	Chloro ester	Bromo ester
Hydroxyadipic acid ...	59%	61%
Dihydromuconic acid	7.2%	6.4%
Cis Cyclobutane acid...	0.9%	1.3%

The figures indicate in a very clear manner the great difficulty with which the formation of the cyclobutane ring is attended as compared with the cyclopropane ring when similar methods of ring formation are employed in the two cases.

The extension of the investigation to αδ-dihalogenated adipic acids afforded an opportunity of investigating the effect on the nature of the products of stereochemical differences in the halogens employed.

The dibromination of adipic acid had been investigated by Willstatter and Lessing, who, on pouring the Hell Volhard bromination product into alcohol, obtained an oily mixture of esters, one of which melted at 66° and was crystallised. There can be little doubt actually that this ester is the meso compound, for on sulphuric acid hydrolysis it gives solely the meso dibromo acid. Ingold discovered that the oily ester was nearly entirely the racemic form of the substance. The third substance present being a dibromo ester which boiled at a constant temperature but could not be purified by distillation ,this being ethyl αα-dibromadipate, this was revealed by its behaviour on mineral acid hydrolysis, the principal product being α-ketoadipic acid identified by the hydrolysis of its oxime to α-cyanobutyric acid and thence to glutaric acid.

It was found that the racemic form of the dibromoadipic ester passes readily into the meso isomeride, it was thought therefore that the corresponding iodo esters might display this tendency towards isomerisation in a lesser degree. The two iodo esters were prepared in nearly equal amounts when either of the alpha delta dibromo esters were treated with a boiling suspension of sodium iodide in alcohol. The two iodo compounds having meso and *racemic configurations.* The meso gave on hydrolysis with dilnte alcoholic potash cis tetrahydrofurandicarboxylic acid, whilst the racemic form gives trans tetrahydrofurandicarboxylic acid. It was found as might be anticipated that the tendency to isomerisation wtih regards the iodo ester is much smaller than in the bromo compound. The meso and racemic dibromo and di-iodo esters when boiled with sodium carbonate yield mainly the corresponding dihydroxyadipic acid, but on treatment with methyl alcoholic potash give a mixture of which mucoiic acid is the main constituent. In certain cases Δ^1 cyclobutane 1 : 2 dicarboxylic acid was also isolated.

The striking fact about the results of Ingold's investigation is the minute yields which were obtained of the four membered cyclobutane ring acid, in comparison to the high yields of three membered cyclopropane acid in corresponding experiments in the glutaric series. Thus for the racemic form of dibromic ester a 2% yield of the four membered cyclobutane ring compound was obtained and for the racemic form of the di iodo ester a 4% yield was obtained. These facts are of course in excellent agreement with the modified strain theory, and illustrate in a very clear way the fact that it is much more diffeult to close the cyclobutane ring than the cyclopropane ring.

Now as has been intimated, the principal points in which Baeyer's Spannungs theory is at variance with the known facts of organic chemistry fall into two classes, the first consisting of those which relate to the effect on ring formation of the number of carbon atoms composing the ring and secondly those relating to the influence of substituent groups.

The earlier work which has been discussed was concerned with a series of comparative experiments by which *it was hoped to* gauge the discrepancies of both types with some degree of accuracy, and at this point Ingold and Farmer decided to extend the investigation to the halogenated glutaconic acids. It is necessary to make some reference at this stage to the researches of Thorpe and his collaborators on the chemistry of the glutaconic acids. The outcome of this work has been that although glutaconic acid, which is no ordinary unsaturated acid, possesses in a diminished degree the unsaturated structure (IV), it has in addition another series of properties which this structure does not suggest and which are suggestive of 1 : 3 unsaturation, the formula of the normal form being the semi aromatic structure (V)

$$CO_2H : CH_2CH : CH.CO_2H \quad (IV)$$
$$COOH.\dot{C}H.CH_2.\dot{C}H.COOH \quad (V)$$

The free valencies being associated sufficiently to limit to some extent the tendency towards 1 :3 addition. And that glutaconic acid is in fact a tautomeric substance, the unsaturated phase (IV) being present in a small amount in tautomeric equilibrium with a large amount of the semi aromatic form.

Now if one compares the formation of cyclopropane 1 : 2 dicarboxylic acid from α-bromoglutaric acid with the formation of Δ^2 cyclopropene 1 : 2 dicarboxlic acid from bromoglutaconic acid (IV) by the elimination of hydrobromic acid in each case, it is clear that the unsaturated three membered ring

acid should be much more difficult to produce. But there is, however, another factor which one must take into account, for in all experiments of this type it is essential to have a guarantee that the effects attributed to differing tendencies towards ring formation are not masked by the differing reactivitiesof the halogen compounds employed.

$$CH<\begin{matrix}CHBr.CO_2H\\CH.CO_2H\end{matrix} \rightarrow CH<\begin{matrix}CH.CO_2H\\|\\C.CO_2H\end{matrix}$$

(V) (VI)

Actually in this case there is a difference in the reactivity of the halogens in the two cases under consideration, bnt the difference is such as to enhance the difficulty in effecting ring closure in the unsaturated compound, and hence for two separate reasons the cyclopropanedicarboxylic acid should be less easily prodnced, and yet actually the unsaturated ring acid is formed a good deal easier than the unsaturated analogue, the cyclopropanedicarboxylic acid being produced considerably easier than the saturated analogue under the experimental conditions which involve the minimal complacations in both cases, but this is not really surprising if we regard α-bromoglutaconic acid as a semi aromatic substance having 1 : 3 valencies in an equilibrium state of limited mutual association.

With regard to the bromination of glutaconic acid, Feist has shown that glutaconic ester readily absorbs two bromine atoms and yields the dibromo ester (VII) this on treatment with diethylamine yields ethyl bromoglutaconate (VIII) in which the position of the bromine atom is proved by the nature of the products formed on complete hydrolysis. The free dibromo acid (IX) has been prepared by Verkade and Coups by the action of bromine vapour on glutaconic acid in the absence of a solvent, but on attempting to prepare α-bromoglutaconic acid by the elimination of hydrobromis acid from the substance, unexpected difficulties were encountered. Many experiments were made with a view to discovering the correct conditions, but although there were obtained indications that the monobromo acid was actually produced in considerable amount, it was always accompanied either by unchanged dibromide or by the products of further decomposition which owing to the labile character of the bromine in the monobromo acid rendered purification difficult. Since a satisfactory specimen could not be obtained, the complete hydrolysis by alkalis of the dibromo acid (9) was investigated by Drs. Ingold and Farmer under the usual standard conditions in the hope that the character of the products would indicate the intermediate formation of the bromo acid which they could not purify.

COOEtCHCHBrCHBrCOOEt
(VII)

COOEtCBrCHCHCOOEt
(VIII)

COOH.CH.CHBr.CHBr.COOEt
(IX)

When the dibromide was hydrolysed, however, certain reactions were observed which were not met with when the monobromo reactions were observed which were not met with when the monobromo ester was employed. Possibly the most remarkable of these was the one by which glutaconic acid itself was prodnced by the elimination not of hydrogen bromide, but of bromine, a type of reaction of which few parallels are known. However, instances which have been recorded of such a mechanism are usnally regarded as indicating an extremely strong tendency towards the formation of the product obtained. Thioindigotin for example is produced by merely heating 1 : 1 dibromo 2 keto dihydro thio naphthen whilst several cases of the passage of the dibromo derivatives of dihydroresorcinol into the corresponding monohromo compounds by the action of alkali were recorded by Thorpe and Norris during their work on spiro compounds (*loc. cit.*). In the latter case the ease of formation is connected with the tendency to acquire the mobile hydrogen atom possessed by a potentially tautomeric system, a tendency well indicated by the facility with which a carbethoxyl group is eliminated as ethyl carbonate from substituted glutaconic esters of the type of COOEt. CR. CH : CR^1. COOEt by the action of cold sodium ethoxide. Once the mobile hydrogen atom is acquired the system becomes tautomeric and shows no further tendency to break down until the interchange with the semi aromatic form is again suppressed by replacing the mobile hydrogen atom by an alkyl group. The formal similarity with the hydrolytic action is clear. The whole difference between the stability of the three carbon system and that of tantomeric systems of other types is one of symmetry, the permanence of the normal forms being dependent on this more than any other

factor. The normal form of glutaconic acid itself is at once the most mobile in its dynamic and the most stable in its equilibrium relations with its unsaturated isomeride of any normal acid of the series, hence it would appear that the effect of molecular symmetry on the three carbon tautomerism is the ultimate cause to which the remarkable tendency towards the production of glutaconic acid, even by abnormal reactions such as the elimination of bromine from dibromo glutaric acid is to be attributed.

The hydrolysis of the dibromo derivative of glutaconic acid is also accompanied by the production of β hydroxyglutaric acid which is obviously a secondary product formed by the addition of the elements of water to the unsaturated form of glutaconic acid during the process of isolation. Verkade has shown that glutaconic acid adds water in this way when an acid solution is evaporated whilst Dreyfus and Fichter proved that the reverse reaction proceeds in the presence of alkali.

Another product of hydrolysis of the dibromo compound is $\alpha\beta$ dihydroxyglutaric acid, the product of complete hydroxylation which is mainly formed when dilute solutions of alkali are used as hydrolysing agents. With regards the substances obtained from ethyl monobromoglutaconate or from the monobromo acid formed intermediately in the hydrolysis of the dibromo compound, it is clear that the final hydroxylation product to be expected is α-ketoglutaric acid into which α-hydroxyglutaconic acid must be converted via its unsaturated modification almost at the moment of its formation.

The keto acid is actually produced in the alkaline hydrolysis. The relatively slight difference between the quantities produced under the two sets of standard conditions studied by Ingold and Farmer (*Jour. Chem. Soc.*, 1921, CXIX., 2001) appeared more unaccountable when considered in relation to the large differences recorded in other cases which have already been discussed until it was suspected that ketoglutaric acid is the ultimate product of two distinct sets of reactions. This was shown by experiment, for cyclopropenedicarboxylic acid (X) although stable to dilute aqueous sodium carbonate is decomposed readily by strong methyl alcoholic potash forming amongst other products, a considerable quantity of keto glutaric acid. The reaction probably involving the transposition of the cyclic double bond followed by ring fission and may be formulated as

$$CH<\begin{array}{l}C.COOH\\ \mid\\ CH.COOH\end{array} \longrightarrow$$

(X)

$$CH_2<\begin{array}{l}C.COOH\\ \parallel\\ C.COOH\end{array} \longrightarrow CH_2<\begin{array}{l}CO.COOH\\ \\ CH_2.COOH\end{array}$$

(XI)

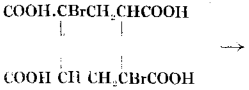
Clearly then, whilst the whole quantity of the keto acid obtained from the products of hydrolysis with sodium carbonate is to be regarded as representing hte extent to which hydroxylation occurred in these instances, the same inference cannot be drawn in connection with the experiments in which methyl alcoholic potash was used, since a considerable proportion of the keto-glutaric acid produced in these cases must have been formed by the fission of the cyclopropane derivative (XI).

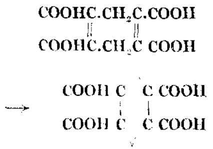
A second substance which is formed in the hydrolytic decomposition of cyclopropenedicarboxylic acid is succinic acid, which is always present in small amounts in the products formed in the hydrolytic fission by means of methyl alcoholic potash. This acid must obviously be formed by the fission of the cyclopropenedicarboxylic acid without previous migration of the double bond, aconic acid being produced as an intermediate product.

At this point it is as well to refer to a very fascinating synthesis of the benzene ring which was accomplished during this investigation, a reaction which constitutes a notable addition to the evidence already adduced to the abnormalities which characterise the transformations which have been discussed in this paper are to be attributed to the semi aromatic character of the glutaconic acid system. The final product of hydrolytic change is pyromellitic acid, which has previously been prepared by Feist from ethyl $\alpha\beta$-dibromoglutarate. Now there is no difficulty in formulating the production of the dihydro derivative of pyromellitic acid from two molecules of the unsaturated modification of α-bromoglutaconic acid.

There are, however, a number of difficulties in connection with this interpretation. For instance, it is far from clear why not a

trace is formed when αγ-dibromoglutaric acid is treated with alkalis under similar conditions. If, however, the conception of 1:3 unsaturation, which is well grounded in the case of the glutaconic acids be extended to the alpha bromo derivative, the formation of the aromatic benzenoid acid





appears to proceed according to the mechanism given above. The results of the experiments of Drs. Ingold and Farmer can be summarised as hereunder :—

	Dibromoglutaric acid		α-Bromoglutaconic ester	
	$2N\ Na_2CO_3$	6N KOH in MeOH	$2N\ Na_2CO_3$	6N KOH in MeOH
Dihydroxyglutaric acid	26	4	—	—
Glutaconic acid	2	5	—	—
Hydroxyglutaric acid	4	7	—	—
Glutaric acid	trace	2	—	—
Ketoglutaric acid	20	14	36	20
Trans Cyclopropane acid	4	2	6	3
Cis Cyclopropane acid	2	6	5	9
Succinic acid	0	1	0	5
Pyromellitic acid	3	10	4	17
Total identified	61%	53%	54%	58

Highbury New Park, N.5

BRITISH ASSOCIATION.

Section I.—Physiology.

FUNCTION AND DESIGN.

ADDRESS BY
PROFESSOR J. B. LEATHES, F.R.S.
President of the Section.

(*Continued from last week, Page* 203.)

Before the days of vertebrates, in pre-Silurian time, an unstable variation in the disposition of atoms and organic combinations of atoms occurred in certain types that was *mainly protein in character, a protein* to the making of which little short of 200 amino acid links must contribute. Coupled to this protein, which probably is not the same in all species of animals in which it is found, is another group containing iron that is probably always the same. This group is of remarkable nature, and is closely related to one that occurs in the far older substance chlorophyll. This complex substance *hæmoglobin had the power of attaching* to itself two atoms of oxygen for each atom of iron that it contained in such a way that it could be readily detached and made available for effecting oxidations. Such was the service that this variation rendered that it is safe to say that withou it there could be no vertebrate creation. It is this service that has made it possible for it to survive to this day, when in the human species alone it is being produced at the rate of about 10,000 tons a day. The story of the service of chlorophyll would, of course, be more remarkable than this.

Natural selection applies to the survival of the chemical forms of living matter as it does to complex living organisms. These *forms, infinitely protean in their variety,* survive and persist in so far and so long as they minister to its self-regeneration. It is the principle of survival by service. Function alone gives permanence to structure. Structure without design is a pathological excrescence that has in itself the

seeds of its own destruction. What does not minister to self-regeneration has no enduring share in life, for self-regeneration is the key to life.

Why is it that what may be termed *official physiology takes so little cognisance* of the doctrine of evolution? These branches of biological study appear to follow courses so exactly parallel that they never meet.

The doctrine of evolution digs down into the foundations of scientific philosophy. If a physiologist addressing physiologists ventures to say anything on this subject of supreme appeal to all biologists it must be in exaltation of the work of those who have approached it from the morphological side, and it may be in hopeful anticipation of the ultimate share in the elucidation of some of its problems to be borne by physiology.

On the part that function plays in the determination of structure it is to be supposed that physiology will ultimately, at any rate, have something more to say. May I submit to the consideration of physiologists certain points in the physiological *development of the machinery of the body* where unless I am mistaken, it is possible to detect the operation of function in determining the design of the machine? The properties and behaviour of cells result from the properties and behaviour of the material composing them. When a muscle cell contracts this is, in general terms, a reversible rearrangement of its parts in response to some alteration in the distribution of forces within or about it due to a disturbance from without. Such reversible reaction to adequate disturbance is a property common in the material of which living cells are composed. In addition to this reversible type of reaction there are irreversible reactions which are characteristic of other kinds of cells, and it is what we call connective-tissue cells that I would ask you to consider. There are several kinds of connective-tissue cells, but they are alike in that they produce and discharge into their vicinity material of a characteristic composition; in some of the commonist this material is chemically collogen, the substance out of which gelatine can be obtained. In course of time these cells come to be embedded in the material which they deposit about themselves and so form one kind of connective tissue. Cells capable of behaving in this way are found, however, which have not yet exercised their faculty; these fibroblasts are then undifferentiated wandering cells that have found no abiding place in the community in which they have their birth. What it is that makes them settle down and start producing the *material in which they come to be* imbedded has never yet been determined. But the most striking structures to which they give rise are the tendons and aponeuroses that make the muscles fast to the bones, and the ligaments that bind the bones to one another. The material that they deposit is composed of inextensible fibres that lie in the case of tendons, at any rate so exactly and exclusively in the line of the resultant of the tension set up in the muscle to which they attache themselves, that is difficult to believe that the disturbance which starts them producing their characteristic secretion is anything else than the pull exerted on them by the muscle fibres to which they are attached; the recurring external disturbances that produces reversible states of tension in the *muscle, indirectly producing in them an* irreversible reaction, which consists in the discharge of material that by its inextensibility can transmit the tension along the line of the force that provokes its deposition. In their simplest form cells of this kind deposit the wavy fibres in areolar tissue which, when straightened out under the action of a displacing force, set a limit by their inextensibility to the dislocation of the part first affected, and so distribute the action of the displacing force over surrounding areas. It is interesting to note that the origin of cells of this kind has been traced to the mesothelium cells that line tissue spaces and serous cavities, the clefts that make the gliding displacements of parts over one another possible. The deposition of fibrous material seems here, as in the tendons and ligaments, to be the result of reaction to the recurring disturbanees set *up by displacements, such, for instance,* as those of the lungs, the alimentary tract, the heart and pulsating vessels, and the deposition occurs in the line of strains set up by the displacing forces. The service rendered by this behaviour of the cells is that the fibres which they deposit, in virtue of their inextensibility, limit the extent of displacement at any one point by distributing it to surrounding parts.

The other component of areolar tissue, the elastic fibres, is similarly produced by other cells. These fibres take a straight

course between their attachments; displacements in the line of their deposition are rendered possible by their stretching, and are recovered from by their elasticity.

The contribution made by such cells to the fabric of the body appears to result from the recurring operation of disturbances, to which they react by depositing fibres along the lines of disturbance.

More striking are the properties of cells upon which the formation of the skeleton depends. The cells that make bone not only secrete fibrous collagen, they also encrust the fibres with insoluble lime salts, and it has long been subject of comment that the rigid bone that results always comes to lie in the line of prevailing strains and stresses. The analysis of the structure, for instance, of the head and neck of the human femur, by Wolff and others who have followed him, shows how *strictly this is true. Calculations* prove that no particle of bone lies anywhere but where the strains dictate. We can predict with certainty, it seems, that it will be found that bone cells are composed of material that in reacting to physical forces directs, in constant relation to the line of action of those forces, the deposition of the substances which make up this connective tissue. Bone can only arise where strains and stresses set up this reaction, and *the greater the strain or stress* the denser the deposit. When a bone is fractured many bone cells are dislodged, and in the abundance of nutriment that ruptured vessels supply, these cells, released from their imprisonment, multiply. At first the force of gravity and the twitching of muscles acting on the soft semi-fluid tissues between the broken ends of the bone supply stimuli that are indeterminate in direction, and such reaction as occurs results only in the *formation of loosely ordered calcareous* fibres; but even this soft callus gives some degree of rigidity, sufficient to restrain the strains gradually to more and more clearly defined lines along which in proportion a stronger reaction can take place. Once it is established that bone corpuscles react to strain and stress by discharging collagen, the intimate spatial disposition of which, as well as of the lime salts with which it comes to be encrusted, is determined by the directing *forces to which it is exposed*; and once it is recognised that the law of spontaneons regeneration requires that this reaction will persist in proportion to the prevalence of these forces, not only must the gradual replacement of callus by appropriate permanent bone necessarily follow, bone in which no particle persists except it be in the line of constantly recurring stress and strain, but it will also necessarily follow that the position of every spicule of bone in the skeleton, cancellous or compact, is the expression of a physiological reaction to the forces of gravity and muscular tension. The evolution of the machinery of the connective *tissues seems to be not entirely the result* of natural selection and the survival of individuals in which this machinery chanced to be of appropriate design. The appearance in early vertebrates of the material that is characteristic of the bone corpuscle seems to have ensured that skeletons would take a shape determined by the direction of the forces to which these corpuscles were exposed, and that the formation of this skeleton is as much a reaction to recurring stimuli *as are the reflexes*, composite movements and postures characteristic for the species.

This conception of the way in which the vertebrate connective *tissues take their* shape transfers a large share of the development of the bodily form back into the nervous system, in which the machinery is stored that directs and determines the habitual movements and postures that in reaction to external disturbances are specific. A physiological account of the evolution of the nervous system, one certainly that is based on the chemical constitution and chemical behaviour of its component parts, must *seem almost infinitely* remote from practical investigation. But the work of Pavlov has made one thing clear, that by a physiological reaction in it machinery may come into existence which did not exist before. The repeated occurrenee of a disturbance at times that are uniformly related to the normal operation of *existing* machinery results in the acquirement of a new reaction which must require machinery that is new. It is rendered probable, if not proved, that this new machinery is situated in what may be called the growing point of the central nervous system, the cortex of the cerebral hemispheres, the part where all is not cut and dry, where cells retain more of the properties of the developing neuroblasts, the properties that enable them to grow out through the embryonic tissues along courses that make it certain that the maturing organism will behave in a manner true to type. In the formation of a conditioned *reflex* two events *are made to* occur in the cerebral cortex at times which are uniformly related to one another; one

of these events, from the constitution of the nervous system, necessarily results in a *certain activity of some muscle or gland, the other has been hitherto in no way related to such a result; after many repetitions of the association of these events it is found that* the one which previously had never resulted in this particular activity, comes to have this result as certainly as the other.

The sight and smell of food in any hungry animal results in the secretion of saliva because the cells to which the effect of these visual and olfactory stimuli is referred are anatomically connected with cells that set the salivary gland in action; the cells on which some particular sound takes effect are not anatomically connected with them, and this particular sound has therefore no effect upon them. But with the establishment of the conditioned reflex the anatomical connection comes into existence. As a result of a functional reaction of nerve cells to disturbances in other nerve cells with which they were not previously anatomically connected, a structure appears which is indistinguishable so long as it lasts from the structures that constitute and other reflex arc. The conditions that determine its persistence or effacement have been, and are being, studied as thoroughly as were those which allow it to appear. The outcome of these studies must be of incalculable importance in evolutional physiology. They are being watched with the keenest interest doubtless by all biologists, but more especially by those who believe that physiology has to take a much bigger part in the solution of some of the fundamental difficulties of biological science than it has been able to take in the past.

But if and when it is possible to trace the origin of structures to functional reactions of cells, and to reactions that depend upon the chemical properties of the cell substance; and if and when this is possible not only in the connective tissues, but also in the nervous system, the functions of which have so controlling an influence on the operation of every part of the body; until it becomes clear that the results of changes in such influence reappear in succeeding generations, the study of functions can have no bearing upon the ultimate problem of biology, the evolutional history of life upon the earth. Pavlov communicated to the last International Congress of Physiology in 1923 some results of experiments that he had done upon this subject which, when confirmed, would electrify the atmosphere. Conditioned reflexes that are established only after many—eighty or a hundred—repetitions of the associated stimulus, in each succeeding generation require fewer and fewer repetitions, and in the fourth may be established after only four. In April of this year he wrote to say that owing to other work he had not been able to give the necessary time to confirmation of these results. We are content to wait.

In the great question whether characteristics developed in the life of an individual have any influence on descendants, experimental evidence must come slowly. In what is called parallel induction a step has been taken which is probably of greater importance than is generally conceded. External influences that affect the bodily characteristics of an organism affect also the germplasm in such a way that these characteristics appear in the first, and even, in a less degree, in the second generation ,born after the external influences have ceased to operate. While such experiments furnish evidence only of a temporary change in the properties of the germplasm, one that may be put down to the lodgment in it of unassimilated foreign matter that is gradually eliminated, the fact that the external germplasm has been shown to be subject to temporal influences must not be belittled. A true mutation is not eternal. Our descendants may be able to dispense with hæmoglobin. Whether the hereditary melanism that in certain moths ,it is said, can be induced by food infected with manganese, is something more than such parallel induction, I hope there may be some present who can say.

Physiological inquiry is a stream that has many sources; its waters gather from quarters far removed from one another. A marvellous meeting took place in the early years of this century when the forgotten experiments of Mendel came to the surface again, and found corroboration in the cytological studies that from about the same time had pursued their slow obstructed way above ground in the endeavour to elucidate the changes in the nucleus of maturing germ cells. In a resting germ cell the chromosomes form an even number ,characteristic for the species; they consist of half that number of pairs of homologues, one of each pair descended from the paternal element in the last zygosis, the other from the maternal. At one of the cell divisions by which the germ cell gives rise to the mature gamete, with half the characteristic number

of chromosomes, there occurs a segregation of the two members of each pair so that they pass into different gametes; the exact cytological equivalent of Mendelian segregation of allelomorphic pairs of characters. To-day the study of genetics and of the 'topographical anatomy of the chromosomes,' with its 'groupings,' and 'crossings over,' seems to call out for chemical assistance. It may be that in the lifetime of some of us those confluent streams of thought and experiment are to be joined by yet another that rises in the vast, remote and, as it must appear to some, muddy swamps of physiological chemistry; and it then, forgetting its 'foiled, circuitous wanderings,' will form with them a 'majestic river,' brimming and bright and large.'

PURE ZINC AT NORMAL AND ELEVATED TEMPERATURES.

By John R. Freeman, Jr., Frederick Sillers, Jr., and Paul F. Brandt.

(*U.S.A. Bureau of Standards.*)

Abstract.

A study has been made of the physical properties and crystal structure of pure zinc. Data are given on the following properties: Coefficient of expansion, density, scleroscope and Brinell hardness, and tensile properties and crystal structure at normal and elecated temperatures. Proof is given than zinc has but one allotropic form between normal temperatures and the melting point.

Summary.

A study has been made of some of the more generally determined physical properties of pure zinc (99.993 per cent.), and also of the crystal structure by the X-ray diffraction method at normal and elevated temperatures. Together with these determinations, particular attention has been paid to the alleged allotropy of zinc.

Data are given on the following properties: Coefficient of expansion, density and scleroscope hardness of annealed and quenched material, Brinell hardness, and tensile properties and crystal structures at normal and elevated temperatures.

In the tensile tests an unusual type of fracture was obtained at elevated temperatures which is similar to fractures obtained in single crystals. A hypothesis is given to account for this unusual type of fracture.

Conclusions.

1. The average coefficient of linear expansion per degree centigrade of pure cast zinc over the temperature range 20 to 100° C. is 0.0000395, and over the temperature range 20 to 300° C. it is 0,0000393.

2. The density of pure cast zinc is 7.131 gms per cm^3. There is no appreciable difference between the density of cast zinc as annealed or quenched from elevated temperatures up to 340° C.

3. The scleroscope hardness of pure cast zinc is not measurably affected by quenching the annealed material from elevated temperatures. The Brinell hardness of pure zinc decreases uniformly from approximately 31 at normal temperatures to 6.5 at 200° C.

4. The tensile strength of pure cast zinc is quite variable, but is probably about 4,000 lbs./in.^{2} at normal temperatures. There are indications of a slight increase in the tensile strength at slightly elevated temperatures followed by a marked and consistent decrease beginning approximately at 100° C.

5. Microscopic studies of etched strain-free surfaces of cast specimens annealed at temperatures up to 390° C. give no evidence of recrystallisation or grain growth.

6. The value for the length of side of an elementary prism of the triangular close packed lattice of zinc (axial ratio 1.86) at normal temperatures is 2.65A.

7. The density of zinc computed from the X-ray data is 7.19 g./cm^3.

8. The crystal form at 250, 380, and 400° C., is the same as at normal temperatures.

9. The data obtained indicate that pure zinc has but one allotropic form.

TEMPERATURE ESTIMATES OF THE PLANET MARS.

By W. W. Coblentz.

(*U.S.A. Bureau of Standards.*)

Abstract.

The present paper gives the results of an investigation of methods of estimating planetary temperatures, especially of Mars, from measurements obtained by newly designed radiometric instruments adapted to these problems. These temperature estimates are based upon radiometric measurements made at the Lowell Observatory, Flagstaff, Ariz., during 24 nights extending over a period of 10 weeks from July to September, 1924.

By means of a series of transmission screens of water, quartz, glass, and of fluorite the planetary radiation emanating from the irradiated surface of Mars was resolved into spectral components. These radiometric measurements were reduced to temperatures by four independent methods of analysis, giving concordant results and showing that the bright areas along the apparent centre of the disc have a temperature of 10 to +5° C., while the contiguous dark areas have a temperature of 10 to 20° C.

During the period covered by these observations the temperature of the north polar region, where winter prevailed, remained fairly constant at −70° C., while in the south polar region, where summer was advancing, the temperature increased to 10° C., or perhaps even higher, at the Martian summer solstice.

The temperature of the east limb, or sunrise side, of the planet is lower than that of the west limb, being 45 and 0° C., respectively, at opposition, August 21. The average temperature of the whole disc in the latter part of June was 30° C. The temperature of the night side of Mars probably drops below 70° C.

Concluding Remarks and Summary.

In glancing over some of the literature on the subject it appears that opinions are well defined and easily arranged into two groups (1) Those who by calculation arrived at the coulusion that the temperature of Mars does not rise above 0° C., and (2) those who from visual observations of seasonal changes in colour, variation iu size of the polar caps, etc., concluded that the temperature rises above 0° C.

It therefore seems proper to emphasise the fact that, during the past opposition, for the first time in history, physical measurements were made which give an indication that the temperature of the surface of Mars rises above the freeing point of watr. As just stated, prior to our measurements of 1922, and especially those of 1924, the opinion prevailed that the temperature of Mars is far below freezing.

In reading the various books and papers on Mars—by Lowell, Pickering, Slipher, and others—it is surprising to find a close parallelism between the deductions of temperature conditions based on visual observations and the foregoing results based upon radiometric measurements. This is probably to be expected, although it was entirely unforseen.

The radiometric measurements were made on 24 nights extending over a period of about 10 weeks, from July to September, 1942. The instruments used consisted of an ironclad Thomson galvanometer and vacuum thermocouples of bismuth and platinum, with windows of rock salt. The receivers, which were 0.23 mm in diameter, intercepted about one-eighth of the diameter of the disc of Mars at opposition.

By means of a series of transmission screens of water, quartz, glass, and fluorite the radiation emanating from Mars and other planets was separated into spectral components and the radiation intensities determined in the spectral regions of 0.3 to 1.4 μ, 1.4 to 4.1 μ, 4.1 to 8 μ, 8 to 12.5 μ, and 12.5 to 15 μ.

In this manner it is possible to determine the shape of the spectral-energy curve of that part of the planetary radiation which is transmitted by our atmosphere and thereby form an estimate of the temperature of the effective radiating surface of the planet.

While the object of the present paper is to summarise the results of an investigation of methods of estimating planetary temperatures with especial reference to Mars, it is relevant to mention that radiometric measurements were made also on Venus, Jupiter, Saturn, Uranus, the moon, and on terrestrial sources; also that the results obtained verify our previous observations, which showed that the planetary radiation emanating from Jupiter and from Saturn, aud transmitted by out atmosphere, is very small, while the planetary radiation from Venus, Mars, and the moon is relatively very intense.

In the foregoing pages the radiometric measurements on the irradiated surface of Mars were reduced to temperatures by four independent methods of analysis, as follows :—

(1) By calculation using the fourth-power law of black body radiation and the water-cell transmissions of the radiation from Mars;

(2) By means of the law of spectral radiation and the ratio of the observed spectral components (A : B) of the Martian planetary radiation, of wave lengths 8 to 12.5μ and 12.5μ to 15μ, as observed through the glass and the fluorite screens;

(3) By extrapolation from the lunar radiation measurements (*a*) by plotting Very's observed lunar temperatures against the observed lunar spectral radiation components, (*b*) by calculating the lunar temperatures from the lunar water-cell transmissions using the fourth-power law and plotting them against the observed lunar spectral radiation components, also (*c*) against the lunar water-cell transmissions (in all, three subsidiary methods); and

(4) By comparison with terrestrial climatic conditions.

These four independent methods give concordant results showing that the dark areas on the Equator have a higher temperature than the contiguous bright areas. The temperatures of the bright areas range from -10 to +5° C. The temperatures of the dark areas range from 10 to 20° C., or even higher.

The average temperature of the apparent centre of the disc, including the bright and dark areas, was about 15° C., verifying the estimate of 10 to 20° C., based upon the measurements of 1922 (B. S. Sci. Paper, No. 460, p. 553).

The temperature of the north polar region when winter prevailed remained fairly constant at -70° C. during the period covered by these observations. The temperature of the south polar cap, as viewed through the atmosphere and mist ,remained fairly constant at about 0° C. until September, when it rapidly increased to 10° C., or perhaps higher. The true temperature would therefore be up to 20° C., or perhaps even higher.

The temperature of the east limb, or sunrise side, of the planet is lower than the west limb. At opposition, August 21, the temperature of the east limb was -45° C., and the west limb 0° C.—both places as viewed through the Martian atmosphere. The true temperature of the surface would be higher.

The average temperature of the whole disc *in the latter part of June was* -30° C. The temperature of the night side of Mars probably drops below -70° C.

The observed high surface temperatures may be accounted for on the assumption that these dark areas contain vegetation having the properties of the tuft-forming grasses of our high prairies and he tussock mosses and lichens of onr dry tundras, which have a high absorptivity for solar radiation and a low thermal conductivity. The assumption of the presence of such a type of vegetation is in harmony with the visual observations which show changes in the colouring of the dark areas with changes in the seasons, and it is in agreement with the low intensity of insolation on Mars. The radiometric observations indicate that during the summer season on Mars temperature conditions at noonday are not unlike the bright cool days on this earth, with temperatures ranging from 5 to 15° C., or 40 to 60° F.

REPORT OF THE GOVERNMENT CHEMIST UPON THE WORK OF THE GOVERNMENT LABORATORY.

FOR THE YEAR ENDING 31 MARCH, 1926.

The chemical work of the following Departments is performed wholly or in part in the Government Laboratories: Admiralty, Ministry of Agriculture and Fisheries, Air Ministry, Colonial Office, Crown Agents for the Colonies, Board of Customs and Excise, Geological Survey, Ministry of Health, Board of Inland Revenue, Ministry of Pensions, Post Office, Department of Scientific and Industrial Research, Home Office, Board of Trade, War Office, Forestry Commission, Privy Council, and Office of Works.

The work for most of these departments is carried out at the laboratory at Clement's Inn Passage. The laboratory at the Custom House, London, deals especially with Customs samples, while the chemical stations, to which reference is made in connection with the work for the Board of Customs and Excise, deal with Customs samples and some Excise samples. In addition, the Department maintains the laboratory in the Geological Survey Museum for the analysis of ores for the Survey, and carries out the inspection of food stores and supplies for the War Office at the Supply Reserve Depot, Deptford, where also there is a laboratory.

The total number of samples examined in the course of the year, includiug those *dealt with at the chemical stations*, is 445,606, as compared with 448,106 in the preceding year, a decrease of 2,500. There has been a decrease in the number of samples examined of 10,685 at the Custom House branch and of 8,138 at the chemical stations, but the number examined at Clement's Inn shows an increase of 16,323. The samples of wine have decreased from 116,547 to 106,395, and of tea from 58,022 to 39,391. There has been an increase of 4,755 in the number of samples of offal tobacco for drawback, and an increase of

2,590 in the samples of exported tobacco and snuff.

Chemical work is performed for the Admiralty in connection with the contract department, the naval yards, the engineering department, and the hospitals. The contracts branch submitted 54 samples of food on tender for report as to conformity with specification and opinion as to relative merits. The technical examining officers at the victualling yards forwarded 233 samples from supplies for examination and report, many of the samples being submitted with the object of preventing the issue of canned goods contaminated with metals.

Other samples to the number of 130 included soaps, tin plates, cordage, canvas, and plated ware.

In addition to the examination of the foregoing samples of foods and general stores, the determination of the salinity of 1,264 samples of sea water was carried out for the Admiralty.

General Notes.

PERSULPHATES.

Crystalline persulphates may be produced by passing fluorine into solutions of potassium bisulphate or ammonium sulphate. The reactions involved are rather complicated. Besides persulphates, sulphopersulphuric acid and other unstable peracids rich in oxygen are produced, which are rapidly decomposed, generating ozonised oxygen. Hydrofluoric acid and fluor-sulphonic acid are also formed. The strong oxidising influence of fluorine is also known to be effective with a number of other substances in aqueous solutions, according to a recent Swiss patent.

CZECHO-SLOVAK FOREIGN TRADE.

Figures for the first six months of this year show a favourable balance of 397 million crowns as compared with one of 874 millions during this period last year. Exports amounted to 7,906 millions and imports to 7,509 millions as compared with 8,918 and 8,044 millions respectively last year. The most remarkable differences between the two years were a great decrease in the import of raw material (partly resulting from the crisis in the textile industry) and a considerable increase of that of foodstuffs. The exports of cereals show a sum of 836 million Kc. as compared with one of 1,102 millions last year. This is largely due to the corn taxes. The main countries from which goods were imported are the following:—

	(In million Kc.) 1926.	1925.
Germany	1,610	3,065
Austria	502	576
Poland	602	440
Hungary	411	369
Rumania	224	182
Jugoslavia ...	227	225
U.S.A.	406	485
France	312	333
Great Britain ...	310	278
Italy	173	499
Holland	203	162
Other countries ...	2,529	1,430
	7,509	8,044

SCIENCE OF TOOL HARDENING.

A firm claims to placed on the market a tool hardening furnace (The Wild-Barfield Electric Furnace), for which perfection is claimed. With the electric control, it is claimed, all guess-work is eliminated. Correct quenching point is shown by the needle on the Magnetic Indicator. The operator cannot over-heat or underheat. He simply watches the needle and quenches immediately it ceases to move. Nothing could be simpler. Nothing could be surer. An unskilled operator can always secure maximum results.

UNIVERSITY OF MANCHESTER—FACULTY OF TECHNOLOGY.

We have received a copy of the exhaustive prospectus for the season 1926-27, which gives a mass of information concerning the Municipal College of Technology, a useful Institution. As shewn in the preface, the college has developed from the Manchester Mechanics' Institution, founded in 1824, in Cooper Street, until to-day it is of University rank and attracts students from all parts of the world. The Owens College, which was opened in Manchester in 1851, has grown into the Victoria University of Mnachester. A Faculty of Technology in the University was established in 1905, with the Principal of the then School of Technology as Dean of the Faculty, and with the heads of the Mechanical and Electrical Engineering, Applied Chemistry and Archi-

tecture departments of the School of Technology as Professors of the University. The Department of Architecture is now confined to Owens College, and the head of the department of Textile Industries as a Professor of the University is now added to the Faculty, together with a number of the College lecturers who are also lecturers in the University. The Dean and the Professors are members of the University Senate. The University Courses provided by the College of Technology lead to the degrees of Bachelor and Master of Technical Science and Doctor of Philosophy (B.Sc. Tech., M.Sc.Tech., and Ph.D.).

INTERNATIONAL COMBUSTION, LTD.

This company have secured contracts this year exceeding two million pounds sterling for its Lopulco powdered fuel apparatus, necessitating extension of its works at Barrow and Derby.

MINERAL RESOURCES ALONG THE CANADIAN NATIONAL RAILWAYS.

This is the title of a book (which is full of facts and figures, calculated to shew the greatness of Canada), which has been issued by the railway authorities. The value of the mineral products in 1925 was $224,846,237. Ontario's mineral production last year was $85,800,000, while the dividends paid last year by the gold and silver mines of Ontario amounted to $10,120,974. There are given many illustrations.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

The following papers were read on June 10, 1926:—

The Heat Production of Stimulated Nerve. By A. C. Downing, R. W. Gerard and A. V. Hill, F.R.S.

Several attempts have been made before to measure the heat-production of stimulated nerve, a matter of obvious importance in view of (1) the fundamental character of the results of similar studies in muscle, and (2) our extreme ignorance of the processes underlying nervous activity.

The method adopted is thermo-electric; methods involving a better utilisation of the energy liberated might be tried, but hitherto we have concentrated on results already definitely obtainable. The thermopile contains about 300 couples of constantan-silver, made by electroplating (Hamilton Wilson), and current is recorded (to 2×10^{-12} amp.) by two moving-coil galvanometers coupled by a thermal relay (Moll and Burger).

The heat appears in two stages: (*a*) during stimulation there is a rise of temperature of about 7×10^{-6}°C. per second of stimulation: (*b*) in the succeeding ten minutes there is gradual further production of heat about 8 times as great as in stage (*a*), which, for the present, we attribute to a recovery progess analogous to that occurring in muscle. Stringent precautions eliminate any heat due to the stimulating current itself.

Total heat corresponds closely to extra CO_2 found by Parker for stimulated nerve. There is difficulty, however, in explaining the *resting* values of oxygen and CO_2 found by him and others.

Observations of the Œstrous Cycle of the Albino Mouse. By A. S. Parkes.

1. The average duration of the œstrous cycle (meta-œstrus to œstrus inclusive) of the unmated albino mouse in the colony maintained at University College, London, was found to be 5.7 days.

2. The average duration of the cycle in normal females mated with vasectomised bucks was found to be 11 days. This postponement of the next œtrous period is considered to be due to the formation of a decidua by the uterus, on mechanical stimulus by the vaginal plug, a process which has been demonstrated in the albino rat by Long and Evans.

3. Pregnancy follows the detection of the vaginal plug in about 70 per cent. of cases, the length of the gestation period being 19 days in almost all cases. During pregnancy the vaginal smear shows no cornified material. About the 10th-12th day blood appears in the vaginal mucus, called by Long and Evans the "placental sign" in the case of the rat.

4. The effect of lactation is entirely to inhibit œstrus (apart from the immediate *post-partum* period) for at least 3 weeks. This result is, however, only brought about where an appreciable number of young are suckled. Rearing of one or two young does not prevent the return of œstrus. After the inhibition due to suckling, the cycle goes

suddenly back to normal, even in cases where lactation is prolonged.

5. Unilateral ovariotomy does not appear to influence the cycle.

On the Occurrence of the Œstrous Cycle after X-ray Sterilisation. By A. S. Parkes. Communicated by Prof. J. P. Hill, F.R.S.

1. Of 25 mice sterilised by exposure to X-rays at 3 weeks old, 22 experienced at least one period of œstrus when puberty was reached. In all, 53 periods of œstrus were observed in these animals, many of which exhibited a series of complete cycles of the normal length.

2. Since none of these animals had oocytes, follicles, or follicular tissue in the ovaries, it is concluded that neither follicles nor *corpora lutea* are essential to the occurrence of the normal cyclic activity of the uterus and vagina.

3. Possible criticisms of these results are discussed, and it is concluded that the œtrous-producing hormone is formed by the inter-follicular tissue, though also possibly by the follicles under normal conditions.

4. The problem of the cyclic action of the sterilised ovaries containing no apparent cyclic structures is dealt with, and it is concluded that the normal ovary possesses some cyclic mechanism which brings about the rhythmic production of œstrus and the coincident maturation of follicles.

MINERALOGICAL SOCIETY.

Appropriately the jubilee of this Society has been eelebrated. On the evening of September 21, a Conversazione was held at the Rooms of the Geological Society, Burlington House London.

The President (Professor W. W. Watts, F.R.S., Professor of Geology in the Imperial College of Science and Technology), in his address, extended on behalf of the Mineralogical Society a warm welcome to those eminent scientific men who had honoured the Society by their presence at its jubilee celebration.

The president devoted the first part of his address to a brief history of the Mineralogical Society, which. however, was not the first of its kind, for it had been aiticipated by one founded in 1799 (of which the minute book is stil extant), which met and worked for seven years ,and in 1807 founded the nucleus from which the Geological Society grew.

At its preliminary meeting, he said, Henry Clifton Sorby took the chair and was elected president. His distinguished eminence and the brilliance and originality of his work gave the Society an excellent start and directed research not only on pure mineralogy, but into the channels of crystal-optics, and the utilisation of optical properties for the determination of minerals and the study of their genesis as individuals or as constituents of rocks. He was followed by Heddle, who filled the *Magazine* with an important series of papers on the Geognosy and Mineralogy of Scotland.

The chief publication of the Society, its *Magazine*, Professor Watts continued, admirably reflected the progress of the science through 50 years, and had made itself of great use to scientific men not only by the original papers published, but by lists of new minerals, and above all by abstracts of work published in Great Britain and abroad.

At first the basis of mineralogy, the study of crystallography, was carried on by a separate and rather academic society, but the two approached and eventually amalgamated in 1883, and henceforth the outlook of the Mineralogical Society was widened and its working power increased by the accession of the university professors and official mineralogists of the period.

NOTICES OF BOOKS.

The Canadian National Railways have issued a splendid volume (apparently *gratis*) entitled *Maps and Information of the Mineral Resources of North-East Canada.* It contains an immense amount of authentic information concerning the natural mineral resources of this part of the Dominion and also gives statistics concerning the production of metals and minerals in various provinces for a long period of years.

It is impossible to summarise the contents of the book, but the conclusion derived from its perusal is that the world will turn to Canada more and more in the future for the snpply of many metals and mineral products. In 30 years Canada's annual trade has risen from 200 million dollars to over 2,000 million dollars.

Theoretical Organic Chemistry. Part I. By Francis Arnall, Ph.D. (London), M.Sc., F.I.C., and Francis W. Hodges, M.Sc. (London). XII + 372. Price 10/6. London : J. & A. Churchill.

This book will be found very useful by either young or advanced students. The

introductory, and early chapters are graded so as to be within the grasp of quite young students, while, as one progresses, there will be found chapters and formulæ worthy of the attention of those much more advanced. We learn that while the authors did not make any special effort to produce a preparatory examination book, yet the work is arranged to meet the requirements of students, private and otherwise, who are going up for their B.Sc., or other examinations. There is given a good alphabetical index, a table of contents, and a list of experiments to the number of 115.

FORTHCOMING EVENTS.

CHEMICAL SOCIETY.

The Chemical Society will hold its first ordinary scientific meeting this Session on Thursday, October 21, at 8 p.m.

At the next subsequent meeting on October 28, the lecture founded in memory of the late Dr. Hugo Müller will be delivered in the lecture theatre of the Institution of Mechanical Engineers, at 8 p.m., by Professor S. P. L. Sörensen, of Copenhagen, who has chosen as his subject: "The Composition and the Characterisation of Proteins."

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS.

The next meeting of the Society will be held on Wednesday, October 6, at the Chemical Society's Rooms, Burlington House, Piccadilly, W.1., at 8 p.m.

The following papers will be read :—

"On the Presence of Compounds of Arsenic in Marine Crustaceans and Shell Fish." By A. Chaston Chapman, F.R.S., F.I.C.

"The Examination of Fish for Formaldehyde." By Arnold R. Tankard, F.I.C., and D. G. T. Bagnall, A.C.G.F.C., A.I.C.

"Potentiometric Titration of Tin with Potassium Bromate." By Karl Sandved.

"The Determination of Nicotine in Tobacco." By R. R. T. Young, M.Sc.

Informal Dinner. — Arrangements have been made for Members and their freinds to dine together at St. James' Restaurant, 178, Piccadilly (opposite Burlington House), at 6.30 p.m. Tea and coffee will be served in the Library at 10 p.m.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

Ordinary meeting, October 21.

CANADIAN PATENT.

264,178.—Method of and Apparatus for Separating Liquid and Vapour.

Filed at the Patent Office, Ottawa, Canada.

The Power Specialty Company, New York City, assignee of John Primrose, of the Borough of Richmond, both in New York, U.S.A., 7 September, 1926. Filed 9 June, 1924. Serial No. 290,,511.

Claim.—The method of separating oil and vapour from a hot mixture of oil and vapour which consists in effecting an initial separation of the oil and vapour by passing the mixture into a portion of a closed chamber intermediate the top and bottom of the latter in rapidly flowing jets which impinge against surfaces within said chamber portion and are thereby broken up, passing the oil from said broken jets in film-like and broken streams through a lower portion of said chamber, collecting the vapour liberated from said streams and mixing it, without contact with the descending oil, with the vapour initially liberated in said chamber, and treating the vapour mixure in the upper portion of said chamber to eliminate entrained oil.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

21,561.—Stevens, Norris & Watson.—Purification of zinc solutions. September 1st.

21,457.—Siemens & Halske Akt-Ges.—System for determining percentage of carbonic acid in gases. August 31st.

21,660.—Thornley, S.—Manufacture of vat dyes. September 2nd.

21,947.—British Dyestuffs Corporation, Ltd.—Manufacture of quinoline derivatives. September 6th.

22,366.—Deutsche Gold-und Silber Scheid-eanstalt vorm. Roessler.—Manufacture of caustic soda. September 10th.

22,146.—Soc. of Chemical Industry in Basle.—Manufacture of dyestuffs. September 8th.

22,415.—Synthetic Ammonia & Nitrates, Ltd.—Production of gaseous fuels. September 11th.

Specifications Published.

257,766.—Nagetgaal, J.—Manufacture of active carbon.

257,820.—Soc. of Chemical Industry in Basle.—Manufacture of dyestuffs containing chromium.

247,556.—Soc. of Chemical Industry in Basle.—Manufacture of dyestuffs.

255,464.—Buchner, M.—Manufacture of hydrofluoric acid.

257,275.—Chemische Fabrik Auf Actien (Vorm. E. Schering).—Process for the manufacture of esters of isoborneol and borneol.

Printed Copies of the full Published Specification may be obtained from the Patent Office, 25 ,Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

Abstract Published.

254,787.—Formamide; hydrocyanic acid.—Badische Anilin & Soda Fabrik, Ludwigshafen-on-Rhine, Germany.

Formamide or hydrocyanic acid or both are prepared by passing vapours of alkyl formates with ammonia over a dehydrating contact mass; high speeds of gas current favour the production of formamide while at lower speeds hydrocyanic acid is the main product; if ammonia is present in excess, ammonium cyanide results; inert gases may be added. Suitable catalysts are alumina, thoria, aluminium phosphate, zeolites, or siliga gel; in an example, methyl formate vapour and ammonia are passed over alumina.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

CAPOSITE.

472,151.—Chemical Substances used in manufactures, photography or philosophical research, and anti-corrosives.—The Cape Asbestos Co., Ltd., Guildhall Annexe, 23, King Street, London, E.C.2. September 15th.

NORMACOL.

467,415.—Chemical Substances prepared for use in medicine and pharmacy.—Chemische Fabrik "Norgine" Dr. Victor Stein, 178, Schwenke-strasse, Aussig-on-the-Elbe, Czechoslovakia. September 15th.

VETERSOL.

470,903.—Disinfectants.—Wright, Layman & Umney, Ltd., 66, Park Street, Southwark, London, S.E.1. September 8th.

TROPOSAN.

472,029.—Chemical substances prepared for use in medicine and pharmacy.—May & Baker, Ltd., Garden Wharf, Church Road, Battersea, London, S.W.1. September 8th.

TURKEOLIN.

471,231.—Chemical substances prepared for use in medicine and pharmacy.—Genatosan, Ltd., 43, Regent Street, Loughborough, Leicestershire. September 8th.

BRITISH PATENT 108,853.
IMPROVEMENTS IN EXPLOSIVES.

The Owner of this Patent wishes to grant Licence or to come into relation with someone competent for the Industrial Working of said Patent.

For particulars write to Mr. A. Van Damme, 7, Rue Du Montenégro, Brussels (Belgium).

WANTED for Shift Work (8 hours) in Steel Works Laboratory, CHEMIST. Salary, £2 10s. per week. Permanent post if suitable.—Apply, giving age, training and experience, to Box H. S. C. 25, *Chemical News* Office.

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THE SEARCH FOR THE MANGANESE HOMOLOGUES OF ATOMIC NUMBERS 43 AND 75.

By W. PRANDTL.

[Translated from *Zeitschrift für angewandte Chemie*, 1926, September 9, pp. 1049-1051.]

In the beginning of June of last year the daily press announced that the long sought manganese homologues, elements of atomie numbers 43 and 75 had been discovered and named Masurium and Rhenium, by W. Noddack, Ida Tacke and O. Berg. At a meeting of the Mathematical and Physical Section of the Prussian Academy of Science on June 11, W. Nernst presented these discoveries and the communication was published on September 4, 1925. The discoverers had already given a brief account of the work in *Naturwissenschaften*, June 26, p. 567 [see translation (abstract) in *Chem. News*, 1925, cxxxi., Aug. 7]. At the meeting of the German Chemical Union in Nuremberg in September, 1925, Ida Tacke again dealt with the subject and described further progress. The lecture was printed in the December 17 issue of the *Zeitschr. f. angew. Chemie*, p. 1157.

Noddack, Tacke and Berg claimed that the manganese homologues could be found in different minerals, especially columbites (niobites) of different origin, by the following treatment.

One kg. of the finely powdered mineral was heated for two hours with two kg. of caustic soda and 0.5 kg. of sodium nitrate. *The mixture was extracted with cold water.* Iron oxide and most of the acidic earth oxides (niobic, tantalic and titanic acids) remained in the undissolved residue. The alkaline solution was next freed from manganese with hydrogen peroxide and then saturated with hydrogen sulphide thus precipitating small amounts of the sulphides of uranium, lead, bismuth and zinc. The filtrate, which now contained only the alkali soluble sulphides was acidified with hydrochloric acid thereby throwing down the sulphides of tungsten, molybdenum, vanadium, arsenic, tin, antimony and germanium. This separation of the sulphides was repeated many times and all the sulphide precipitates were put together. From 1 kg. of mineral about a gram of sulphides was obtained.

The final solution freed from precipitable sulphides was evaporated and the residue again taken up with concentrated hydrochloric acid. The acid solutions were again treated with hydrogen sulphide, finally neutralised and precipitated with mercurous nitrate. In this way, in addition to the chloride solution a small precipitate appeared which was added to the sulphide precipitates.

These combined precipitates were heated in a stream of hydrogen in order to remove the sulphur and mercury. The final residue was examined röntgenspectroscopically.

This usually revealed the lines of niobium, tantalum, tungsten, lead, zinc, tin, and in most cases the principal line ($K\alpha_1$) of 43 was visible. More rarely the principle line ($L\alpha_1$) of 75 could be seen.

To increase the content of the manganese homologues it was necessary to repeat the complete procedure with the combined preparations as above. The final quantity of enriched material is thereby reduced to 1-10 mg., containing about 5 per cent. of element number 75 and 0.5 per cent. of element number 43.

According to a private communication, Noddack and Tacke later added 5 per cent. ammonium chloride solution to the alkaline extract so that the acidic earth oxides were completely thrown out and remained in the insoluble residue, together with a great part of the aluminium, tin, lead, etc. The alkaline filtrate was then further treated as indicated above. The combined preparations were finally treated with aqua regia and concentrated. Tungstic acid remained insoluble, while eka- and dvi- mananese remained in solution together with molybdic acid.

In 1913 I had about 50 kg. of columbite from Norway. This was fused with sodium bisulphate and extracted with water, the extract being acid, and having removed the acidic earth oxides, I treated the solution by the usual methods for removing uranium, iron and manganese.

The iron-manganese fraction was examined by Dr. A. Grimm for manganese homologues. After fractional crystallisation of the double iron and manganese ammonium sulphates he submitted the fractions to rontgen spectroscopic analysis. This was recorded in his dissertation (University of Munich, 1924: "Rontgenspektographische Untersuchungen auf dem Gebiete der seltenen Erden.")

There were no indications of the presence of any homologues of manganese.

As I still had some kg. of the columbite used in the above work and Dr. Grimm had in the meantime constructed an improved spectrograph, I was able to test the work of Noddack, Tacke and Berg immediately after the publication of their work. Following their method, at my suggestion, W. Francke worked up 1 kg. of columbite from South Norway, 900 gr. of manganese tantalate from Steinkopf in British Namaqualand, 1,200 gr. of tantalite frim Kimito in Finland, 1/2 kg. of gadolinite from South Norway, and 600 gr. of wolframite from Zinnwald. He examined the material isolated rontgenspectroscopically and found that it consisted chiefly of tungsten, molybdenum, niobium, tantalum, manganese, iron, and sometimes arsenic as well, but he could not find any traces of manganese homologues.

During the oxidation fusion it is possible that the volatile higher oxides of the manganese homologues would be formed and would volatilise when the hydrochloric acid evaporation was carried out. Francke therefore further treated 1 kg. of niobite from South Norway and 2 kg. of columbite from Finland, according to the method of Noddack and Tacke, with caustic soda and sodium nitrate, but the alkaline manganese-free solution was neutralised with nitric acid to avoid the use of hydrochloric acid before precipitating with mercurous nitrate. After heating in a stream of hydrogen the precipitate weighed 0.5—1.0 gr. per kg. of mineral and consisted essentially of the same bodies as Noddack and Tacke had found in their residues, *viz.*, tungsten, molybdenum, niobium, tantalum, iron, manganese, zinc and arsenic, but contained no eka- and dvi-manganese.

At the beginning of this year, I informed Noddack and Tacke that we could not obtain the new elements by following their procedure, and I requested them to allow me to have for rontgenspectroscopic analysis the preparation in which they had found eka-manganese. They sent me about 8.5 mg. of a black product which should contain about 0.8—1.0 per cent. of rhenium (75). According to Dr. Grimm's spectroscopic analysis, this substance consisted chiefly of iron, some manganese and small amounts of tantalum and traces of tungsten. He could not find any rhenium in it. Dr. Grimm is of opinion that he could detect 0.1 per cent. of an admixture with his spectrograph. It should be remembered that the principal line of element 75 $L\alpha_1$ (wave-length = 1430.6 X-units) lies very close to the $K\alpha_1$ line of zinc (wave-length = 1432.1 X-units), so that both lines can only be distinguished by high dispersion and with small slit. Our apparatus fulfilled there requirements. Further, the $L\beta_1$ line of 75 (1235.5 X-units) almost coincides with the tungsten $L\beta_8$ line (1235.4 X-units). The two strong lines of the rontgen spectrum of 75 $L\alpha_1$ and $L\beta_1$ thus fall so very near the strong line of zinc and a weaker one of tungsten.

Berg's spectrogram shows the $K\alpha$ lines of zinc and also quite plainly the very strong spectrum of tungsten, which is natural, as he employed a glowing tungsten cathode. Dr. Grimm worked with a gas-filled tube without a glowing cathode. Our apparatus possessed a somewhat greater dispersion than that of Berg. His spectrogram of the specimen of rhenium sent to us by Noddack and Tacke was not convincing. It showed only the zinc $K\alpha_1$ line somewhat washed away, which Berg had considered as proof of the presence of 75.

In order to clear up the affair I sent Dr. Grimm to Berlin to become acquainted with their spectrograph and to find out by personal conversation with Noddack and Tacke the cause of the discrepancies.

The originals of the two plates which Noddack, Tacke and Berg had given in their account of the discovery of the manganese homologues convinced Dr. Grimm, and also convinced Prof. V. M. Goldschmidt in Oslo, that they were satisfactory, but it appears that they had originated from one preparation, now lost. Other plates which Berg had used as proofs of the presence of manganese homologues did not appear convincing to Dr. Grimm, who also gained the impression that the data upon which Berg had based his spectroscopic conclusions of the contents of the elements sought was fixed too high. After his return from Berlin, Dr. Grimm changed the crystal of his spectrograph with one from Berg. Whilst he had been using as lattice a calcite crystal, Berg had used two rocksalt crystals which, when set at different angles made it possible to examine two regions when using the same plate. Rocksalt reflected better than calcite for this and gave stronger spectra for the same time of exposure.

With the new arrangement, Dr. Grimm has recently examined numerous preparations made by Francke, according to Noddack and Tacke's method, which should be rich in manganese homologues. He could not, however, detect the presence of these elements.

From Noddack and Tacke's communication it is seen that they could not be sure that their procedure would give a product containing the new elements. Whilst we have employed minerals in coarse lumps, thus easily identified, Noddack and Tacke, according to private information, have been using commercial minerals already in a powdered condition, as their starting material. It is thus quite possible that ther columbite had been mixed with some unknown mineral which contained the manganese homologues, whilst our columbite was not so contaminated.

As a consequence of our enquiry into the work of Noddack, Tacke and Berg, we must state that their results cannot be reproduced and we could not detect the new elements in any of the minerals which they state should contain these bodies. The discovery of the manganese homologues by them can only be recognised when their enriched preparations are free from tungsten and zinc.

Following Noddack, Tacke and Berg's account of the discovery of these elements, two English and two Czech investigators independently announced that the manganese homologues, especially element 75, were present in the manganese compounds of commerce. The first, F. H. Loring and J. G. F. Druce (*Chem. News*, 1925, CXXXI., 278, 289, 305, 321, 337, 371), stated that whilst searching for the element 93 they had found the element 75 in commercial $MnSO_4$. In pyrolusite they claim to have found not only this element but also eka-Cs, eka-I and element 93.

[If we understand the author correctly, this statement puts the claim too high. —TR.]

If all these new elements are said to be present in material so commonly used, it seems improbable that the long-sought element of atomic number 75 should be contained in large and easily identifiable amounts in a substance which has been so thoroughly investigated.

Nevertheless, Francke has attempted to isolate element 75 from commercial Mn salts and from pyrolusite (Braunstein) according to Druce's method.

The procedure in his separation starts from the assumption that the element 75 is not precipitated by H_2S from acid or from alkaline solution. The ammoniacal solution of manganous salts was therefore treated to saturation with H_2S in the presence of a sufficient amount of ammonium chloride until all Mn, Fe, Al, Cr, etc., were precipitated from solution. The filtrate is then heated till NH_3 and H_2S were driven off, acidified with HCl and evaporated. The residue was ignited to remove ammonium compounds. The residue was taken up again in acetic acid and freed from Ca by precipitation with ammonium oxalate. The filtrate is then evaporated, ignited and dissolved in HNO_3 and precipitated with ammonia. This precipitate should contain the element 75.

In this manner, Francke worked up 500 gr. $MnCl_2$, 500 gr. $MnSO_4$, and finally also 2 kg. of pyrolusite. He treated the NH_3 ppt. with HF and H_2SO_4 to free it from SiO_2 and to increase the eka-Mn content, and finally reduced in a stream of H_2.

The X-ray investigation of the residue—a dark powder of about 50 mg.—indicated the presence of W. The pyrolusite preparation especially showed the presence of W, Fe and Mn, but the absence of 75.

Evidently the presence of W and Zn had misled Loring and Druce into the belief of the presence of 75.

From investigations of the electrolytic deposition potentials of Mn from Mn salt solutions, with the help of a Hg-cathode and automatically registering polarographs, V. Dolejšek and Heyrovský (*Nature*, 1925, CXVI, 762) arrived at the conclusion from the irregularities in the curves, that impurities were present even in the purest preparations of Kahlbaum and of Merck ("pro analysi") and they are convinced that these impurities could only be the homologues of Mn (Nos. 43 and 75).

The isolation and identification was conducted as follows. Strips of zinc or of Pt foil connected with zinc rods were placed in concentrated solutions of a manganese salt, so that all metals with a less negative potential than zinc would separate. The deposit was scraped off, dissolved in HCl and the solution evaporated or precipitated with NaOH and the X-ray spectrum taken.

The $L\beta_1$ line of element 75 (which, as already mentioned, coincides with a W line) was observed, as was the $L\alpha_1$ line of 75, which is very near the $K\alpha_1$ line of zinc.

Considering the large amount of zinc which was brought into solution by this method, Dolejšek and Heyrovský then selected another method. A small dish containing Mn amalgam was put in a saturated $MnSO_4$ solution in contact with a large piece of Pt foil. After some days the Pt foil was removed and scraped and the deposit dissolved in concentrated HCl. This solution was diluted, neutralised with NaOH and after acidifying with acetic acid, precipitated with H_2S to remove zinc, nickel, cobalt, etc. The filtrate from the sulphide ppt. was said to contain about 2 per cent. of the element 75 as well as Mn. As a characteristic property of the element 75 it was stated that the HCl solution of the chloride was coloured green. In the X-ray spectrum the following lines were observed: $L\alpha_1$, $L\beta_1$, $L\beta_2$ and $L\gamma_1$, that is, lines which coincide with those of zinc and tungsten.

The repetition of Dolejšek and Heyrovský's experiments by Francke had the following result.

Commercial $MnSO_4$, even the purest Kahlbaum "pro analysi," contained small quantities of tungstic acid Zn and Co, but no trace of eka- and dvi-manganese. The green colour of the HCl solution of the chloride which we have also observed is caused by the presence of a small amount of cobalt. If manganese oxide heated in air is dissolved in concentrated HCl and a drop of a very dilute $CoCl_2$ solution is added to the solution, exactly the same green colour as Dolejšek and Heyrovský observed is obtained. We also obtained it on repeating their work.

According to private information, Noddack, Tacke and Berg have not discovered the homologues of Mn in their repetition of the work of Loring and Druce and that of Dolejšek and Heyrovský.

In the publications of Loring and Druce and of Dolejšek and Heyrovský, only 75 is considered, *i.e.*, element 43, the masurium of Noddack and Tacke, apparently has not been observed by anyone else.

Grimm's spectrograms give no indication of its presence although its X-ray identification would be easier than for that of 75, in so far as no other rontgen lines coincide with those characteristic of 43. Noddack, Tacke and Berg appear to have obtained only one plate which shows its lines, which were in any case extremely weak.

The question whether eka- and dvi- manganese have already been discovered cannot, in my opinion, be answered yet. It can only be affirmed when preparations free from zinc and tungsten have been obtained in a manner which can be readily repeated, and which show the rontgen spectrum without any doubt whatever.

[We are publishing shortly a translation of a recent paper by Walter and Ida Noddack. Loring and Hilger (Ltd.), have been investigating strange lines arising from certain mixtures placed on the anticathode (see *Chemical News*, May 14, 1926, p. 311), and their results, we are informed, are already of interest, but publication is being delayed pending further confirmatory experiments.—Ed., *Chemical News*.]

AIR HEATING FOR STEAM BOILERS.

An Interesting Report from the United States.

By A Well Known Engineer.

The scientific principle in general furnace operation of heating the incoming cold air by means of the outgoing hot gases, so long a common practice in the carbonisation industries, for example, is now beginning to be extensively employed for steam generation, and very interesting is the recent

report of the National Electric Light Association (New York) on "Stokers and Furnaces." This is a review of mechanical stoker developments in the United States during the previous twelve months, 1925-1926, with a section devoted to air heating, and although naturally the publication is concerned mainly with power station and water-tube boiler conditions, it is of great interest to all steam users because air heating can be fitted to every type and size of boiler.

From the chemical point of view the chief point is perhaps that of corrosion, one of the objections to the air heater in the past because of the sulphur in the flue gases. It is claimed, however, that the modern air heater does not corrode, and the "N.E.L.A." Report certainly tends to confirm this opinion, as represented by the results of experience and very close observation in a number of the largest and most up-to-date power plant in the United States.

To take one example, very interesting is the case of the Kansas City Power and Light Co., Kansas City, Mo., who state that they put into operation at their North-East Power Station in July, 1923, an "Usco" multiple plate air heater, which, of course, is a British invention originally introduced by the Underfeed Stoker Co., Ltd., of London, in 1907. In this case all kinds of coal were used, some of which was of the worst possible character, containing 4-5 per cent. sulphur, typical examples being low grade Missouri bituminous coal of only 8,700 B.Th.U., and Arkansas anthracite of 11,500 B.Th.U. So far, after approximately three years' running, there is no sign of any corrosion of the plates, although these have been specially drilled for chemical analysis and investigation. Also it is the opinion at this station, as in others in America, that the best method of cleaning air heaters is by washing down with water, while in connection with the subject of cleaning air heaters the report states that the modern apparatus is no more difficult to clean than the feed-water economiser. We have to remember, however, that all these installations have not been running more than two or three years, and data with regard to depreciation and wear and tear will be still more interesting after five or six years, but of the generally efficient results there is no question, and the principle ought to be extended to many furnace operations in the chemical industries.

General Notes.

NEW GOLD DISCOVERY EAST OF RED LAKE, (CANADA).

The Natural Resources Intelligence Service at Ottawa reports that a spectacular discovery in the vincinity of Narrow Lake, some 30 to 35 miles northeast of Red Lake, in the district of Patricia, is reported by Mr. Jack Lindsay, who has just come out from that district showing samples of free gold, and which are stated to render the find among the most important discoveries made in recent years. The news of the discovery has been followed by a rush of men from Hudson and Red Lake during the last few days. The vein where discovered in this section is over 25 feet in width and highly mineralized.

EVIDENCES OF GERMAN ECONOMIC STRENGTH.

During the last sixteen months Germany has passed through what will probably prove to be the severest stage of her post-inflation recovery, writes Mr. J. W. F. Thelwall, M.C., British Commercial Secretary at Berlin, in his Report on Economic during 1925-26. It was sharp, but short, and the country has once again shown its remarkable power of recuperation. Troubles are by no means over and reactions will occur from time to time, but there is no reason why Germany's development from now on should not, on the whole, be upwards.

The dominating factor throughout the period under review was the acute shortage of working capital and of credit. From the middle of 1925 until last March, this reached almost unbelievable dimensions, ready money payments having very nearly ceased. The banks, following the lead of the Reichbank, held aloof from industrial and commercial commitments and let the crisis work itself out; undoubtedly the best plan, as the event has shown, though, while it lasted, the remedy was extremely unpleasant.

BANKRUPTCIES AND UNEMPLOYMENT.

There are two sets of figures which reflect very accurately the descent towards the lowest point and the commencement of the subsequent improvement; these are the statistics of bankruptcies and of unemployment; they show particularly clearly how the movement, which was at first latent,

came to a sudden crisis and then gradually subsided. It should be explained that apart from bankruptcy, firms which fear that they may get into difficulties are, in Germany, permitted to apply for official control, for the duration of which they practically enjoy a moratorium, as an action for payment may not be brought; when the firm's affairs are again in order this control is withdrawn, and a large number of such withdrawals is accordingly a sign of general improvement. The bankruptcy figures are as follows:—

The total number of bankruptcies in 1913 was 9,725, and in the following year 7,739. The control system is a war measure introduced in August, 1914.

1925.

Particulars.	First Quarter	Second Quarter	Third Quarter	Fourth Quarter
	2,210	2,144	2,402	4,057
Bankrupteies	731	827	1,161	2,743
Firms placed under control	535	479	576	734
Withdrawls of control				

Total bankrupteies in 1925 : 10,813.

1926.

Particulars.	Jan.	Feb.	Mar.	Apl.
Firms placed under control	2,013	1,920	1,710	1,261
Bankrupteies	1,428	1,465	1,426	855
Withdrawls of control	400	427	760	836

The unemployed numbered 535,529 on January 1st, 1925, and 673,315 on December 1st. On January 1st, 1926, the number was 1,497,576 and on 1st July, 1,743,000. The number went up to over two millions in February and March. There are about 4 millions more persons seeking employment now than before the war.

THE MONETARY POSITION.

It is evident that under the conditions, Germany's commercial life would have broken down completely if it had not been assistance was forthcoming in the shape of a considerable influx of foreign capital, chiefly from the United Kingdom and Holland and a few other countries. Reliable estimates place the total which has come into the country from 1924 onwards at about £200,000,000, including the Dawes loan and short- as well as long-termed money. The earliest loans were fairly expensive and cost borrowers 10 to 11 per cent., but with increasing confidence and the glut of money in the States, rates became easier, and by April of this year German issues could be placed at 7 per cent.

OLD ELLESMERIANS MEMORIAL CHAPEL.

The ceremony of laying the foundation stone of the Memorial Chapel at Ellesmere College, Ellesmere, Shropshire, took place on Wednesday afternoon, September 29, amongst a large assembly of Church Dignitaries, the Governors and Fellows of the College, Sir Offley Wakeman, Bart., the Custos of the College, the Rev. T. H. Hedworth, M.A., the retiring Headmaster, D. R. Evans, Secretary, as well as past and present boys, their parents and friends.

The Chapel, which is designed on broad lines to accord with the present extensive School Buildings, has been designed by Sir Aston Webb. The cost is being defrayed by contributions from various sources, but principally from the Old Boys of Ellesmere College, to whom it is designed as a memorial to commemorate those who fell in the war.

After the procession had been formed in the large School the assembly moved from the Temporary Chapel to the School Ante Hall where the first part of the office was said by the Provost of the School, Prebendary Talbot. The procession then proceeded to the site of the Foundation Stone, and the Custos of the College, Sir Offley Wakeman, then declared the same "well and truly laid."

A return was then made to the Ante Hall and the Provost of Lancing (Bishop Southwell) gave an inspiring address and made an eloquent appeal to the Boys to make themselves worthy citizens of the great British Empire. A collection for the Building Fund of the Chapel closed the proceedings.

COAL OUTPUT IN DIFFERENT COUNTRIES.

In July, 4,228,000 tons of coal was mined in France; 12,864,000 in Germany, and 46,340,000 tons in the U.S.A.

BRITISH DISINFECTANT FOR NEW ZEALAND.

The High Commissioner for New Zealand in London reports that manufacturers of disinfectants have recently been circularised asking them to tender for supplies of disintectant required by the Government Departments, schools, etc., in New Zealand, covering a period up to three years. Stipulations made are that the disinfectant must be of British manufacture, and the name of the manufacturer must be stated. As there are a very large number of Government Departments in New Zealand, this order will be a very extensive one.

CARNEGIE INSTITUTE OF TECHNOLOGY.

The Conference on Bituminous Coal, to be held at the Carnegie Institute of Technology, in Pittsburgh, Pennsylvania, U.S.A., has been definitely scheduled for November 15 to November 19, 1926, accordng to an announcement from the institution.

As a result of a visit to Europe this summer by Dr. Thomas S. Baker, president of the Carnegie Institute of Technology, it is announced, several distinguished scientists and fnel technologists in Europe have accepted his invitations to attend the Congress. German representatives will include Privy Councillor Professor Franz Fischer, Director of the Institute for Coal Research at Mulheim-Ruhr, and Dr. Friedrich Bergius, of Heidelberg. England will be represented by Dr. C. H. Lander, Director of Fuel Research of the Department of Scientific and Industrial Research; Dr. R. Lessing, prominent fuel technologist; and Geoffrey Gill, engineer and specialist in the manufacture of gas. From France will be General Georges Patart, who was in charge of the manufacture of explosives during the war, and who is the inventor of a process for making methyl alcohol from coal. In addition, there will be a representative from the Office National des Combustibles Liquides. Besides these, it is announced, there will be a number of European specialists who have done work in the development of certain processes.

American scientists, chemists, and fuel technologists who have been doing important research work in the chemistry of coal and other problems will have a large share in the programme.

The purpose of the meeting, according to President Baker, is to bring together the men of all countries who have done notable work in the study of more scientific and rational utilisation of soft coal. Listed for discussion are such questions as the manufacture of substitutes for gasoline from coal, the complete gasification of coal, high temperature and low temperature carbonisation, by-products, smokeless fuel, pulverised coal, hydro-electric power versus steam power, etc.

Among the members of the Advisory Board assisting in the development of the Conference plans are several American men of affairs.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

Papers read on June 10, 1926:—

The Viscous-Elastic Properties of Smooth Muscle. By A. V. Hill, F.R.S.

1. Gasser and Hill found that the sudden release, during an isometric tetanus, of the skeletal muscle of a frog is followed by an instantaneous drop of tension, and then by a gradual redevelopment along a curve identical with that of the original rise when stimulation began. This observation has been repeated, both for quick releases and for quick stretches, on the smooth muscles of *Holothuria nigra*, in which the speed of contraction is less than 1/100 of that of frog's striated muscle. The return to the tension characteristic of the new length is precisely similar in its time relations to the initial rise of tension.

2. It is concluded that the development of a contraction during stimulation, and its redevelopment after release, are due to the same process, viz., the formation of an organised molecular pattern, arranged in space whether of two or three dimensions in the fibres of the muscles. Such a molecular rearrangement, either on stimulation or during actual shortening, is the basis of the "viscous-elastic" phenomena found in all contractile tissues.

Contributions to the Knowledge of Lower Carboniferous Plants. By J. Walton. Communicated by Prof. F. E. Weiss, F.R.S.

Rhacopteris.—A brief account is given of the extent of our knowledge of the morphology of the genus.

A specimen of *R. inaequilatera*, consisting of a portion of a branch or stem with 2 fronds attached, is described and figured.

R. fertilis, n. sp., a fertile frond of *Rhacopteris*, with no sterile pinnules, is also figured and described.

The evidence adduced is considered to support the view that *Rhacopteris* is more probably a fern than a pteridosperm.

The following types of fronds are described and figured:—*R. circularis, sp. n.*; *R. petiolata* Göpp *sp.*; *R. sp.*; *Sphenopteris* (*Rhacopteris*) *Weissii, sp. n.*

Sphenopteris.—The presence of a rachis in the angle of the fork of the frond of *S. Teiliana* is demonstrated in several specimens, and shown to have some characters of a fertile rachis of *Telangium*, and is interpreted as indicating the fundamentally pinnate structure of the frond, the apex being presumably fertile in some fronds, represented by a rudimentary structure in others, and completely suppressed in yet others.

An examination of *Telangium bifidium* in light of these new facts shows that very attached to the frond bearing the foliage pinnules in the angle of the main fork of the rachis, and that possibly in many Lower Carboniferous fronds, with apparently dichotomous rachis, the frond is in reality pinnate in structure.

A Comparative Study of Turacin and Hæmatin and its Bearings on Cytochrome. By D. Keilin. Communicated by Prof. J. Barcroft, F.R.S.

Acid hæmatin prepared from Hb is a colloidal suspension of hæmatin which is not united with globin, but is protected by the latter from precipitation. Alkaline hæmatin prepared from Hb and from hæmin crystals is the same substance, both being an iron-porphyrin compound devoid of protein. The absorption spectra of turacin, hæmatin and hæmochromogen vary with the degree of dispersion of these compounds, and the bands shift from 100 to 200 A towards the red end of the spectrum as the degree of dispersion decreases.

Artificial hæmochromogens composed of hæmatin and one of the nitrogen compounds can be prepared, showing either 3 or 4 absorption bands resembling those of cytochrome. Evidence is brought forward that the three components of cytochrome are derived from one hæmochromogen compound, present in two distinct degrees of dispersion (b' and c), and partly modified (a') by active process of oxidation and reduction in which these components are directly involved.

The Equations Applicable to Simple Hæmolytic Reactions. Communicated by Sir E. Sharpey Schafer, F.R.S.

In this communication the equations applicable to simple hæmolytic phenomena are discussed, with especial reference to time-dilution and percentage hæmolysis curves of experiment. It is shown that the action of the simple lysins on the cells is describable by expressions like those for chemical reactions of the first order, but in which is a term relating to extent of cell surface acted upon. Such expressions, together with certain assumptions regarding distribution of resistances of cells, are enough to explain experimental results in their entirety.

In addition to these considerations, the fact that the reaction takes place at cell surfaces only, and not continuously throughout the system, is taken into account. When this condition is allowed for, it is shown that the effect of lysins on suspensions of different strengths is explained in a simple way.

From the expressions is deduced the result of a previous communication, in which the relation of different hæmolytic systems to each other was discussed. The applicability of the expressions used is illustrated by comparison of experimental and calculated results.

THE INSTITUTE OF METALS.

The programme of the Institute of Metals for the session 1926-27, dating from October 1, has just been issued. It covers not only the work of the parent Institute, but also that of its six local sections centred in various metallurgical districts. Over forty lectures, dealing with various phases of metallurgy, are enumerated in the programme; these include the annual May Lecture, to be delivered by Sir Henry A. Miers, F.R.S. Copies of the programme can be obtained from the Secretary, Mr. G. Shaw Scott, M.Sc., 36-38, Victoria Street, London, S.W.1., who is also able to supply —at 2s. 6d. each—copies of any of the sixteen papers read at the recent Liège Meeting of the Institute.

NOTE ON THE CORROSION OF AN ANCIENT TIN SPECIMEN.

By PROFESSOR C. O. BANNISTER, M.Eng., A.R.S.M., Member (Liverpool).

Before the Institute of Metals, March, 1926.

Very little information is available in our literature on the corrosion of metallic tin, although it is a metal generally known to be highly resistant to corrosion. It is known to have been used as a constituent of bronze since about the year 2500 B.C., but there are remarkably few specimens of ancient objects of metallic tin in our museums which are available for examination, although the metal was probably obtained as such about the year 2000 B.C. Tin was probably used by the ancients for a much larger variety of objects than that represented by specimens still in existence, and the scarcity of these specimens is probably due to the fact that metallic tin, as we know it, is only stable at temperatures above 18°, and at lower temperatures it changes into another modification, the change being accompanied by expansion and disintegration.

The author has recently had the opportunity of examining a metallic tin sheath from the Shrewsbury Museum, which had previously been described as "bronze, but looks like lead." The specimen is recorded in Prebendary Auden's list in the "Victoria County History of Shropshire," vol. i., p. 202, as: "Bronze scabbard-end in Shrewsbury Museum, found at the foot of Caradoc." From information supplied to me by Miss Chitty, I learn that the specimen was found in a gutter in Roman Watling Street, Church Stretton, by the late Mr. John G. Dyke, about 1900. It was exhibited on May 15, 1924, at a meeting of the Royal Society of Antiquaries. It was thought to be of lead, and the consensus of opinion seemed to be that it was mediæval, or possibly Roman, probably only a makeshift welded on to the broken point of a scabbard. The scabbard-end, as received, was 7.8 cm. long and 4.2 cm. wide at the open end.

The whole of the article was covered with an adherent corrosion product about 2.5 mm. thick, and the inner layer of remaining metal was 2 mm. thick. The analysis of the metal gave:

	Per cent.
Tin	99.98
Copper	trace

This shows remarkably pure metal, and its preservation during the ages must be due to a peculiar and happy set of conditions which ensured its never reaching a low enough temperature to allow of the disintegrating action of "tin-pest."

The corrosion product obtained from the surface of the metal gave on analysis the following figures:—

	Per cent.
Tin	76.82
Water (combined)	5.10
Copper oxide	0.81
Sulphuric anhydride	0.85
Iron oxide, etc.	0.12
Lime	0.10
	83.80

On heating the original material in dry air, water was driven off, but the weight of the product after heating was found to be practically the same as the original weight.

In a carefully conducted experiment the water driven off was found to be 5.1 per cent. and the oxygen absorbed 4.51 per cent.

From these results it appears that the tin was partly present as hydrated stannous oxide and partly as anhydrous stannic oxide. Calculating from these figures, we have:

Stannous oxide 38.25 } Water (combined) 5.10 } Hydrated stannous oxide	43.35
Stannic oxide	54.68
Copper oxide	0.81
Sulphuric anhydride	0.85
Iron oxide, etc.	0.12
Lime	0.10
	99.91

It would appear from this result that the mechanism of corrosion of metallic tin comprises the formation of hydrated stannous oxide, and the subsequent oxidation and dehydration of this compound to stannic oxide.

BRITISH ASSOCIATION.—ABSTRACTS.

CHEMISTRY SECTION.

Discussion on Tautomerism. By PROF. C. K. INGOLD, F.R.S.; PROF. T. M. LOWRY, F.R.S.; DR. G. R. KON, DR. R. P. LINSTEAD; PROF. J. F. THORPE, F.R.S.

The scope of Tautomerism (reversible isomeric change) is prescribed by reference to the fundamental types of addition re-

action of which tautomeric change represents the intramolecular case, the basic condition being the simultaneous presence of mutually suitable dissociable and unsaturated centres. From this standpoint some long known, and some recently investigtaed, types of tautomeric change are discussed, with reference to the effect of structural conditions on Mobility and Equilibrium. Comparisons are drawn between the directive effect of groups in aromatic substitution and their ability to 'direct' the mobile hydrogen atom into the favoured position.

The above points are illustrated by reference to such classes of compounds as *cyclo* Pentadienes, Benzene derivatives, Glutaconic esters, Nitro-compounds, Sugars, Oximes, and Diazo-compounds, and explnations based on the assumption of Tautomeric change are given for certain peculiarities of these substances.

The Use of Hydrogenation in Organic Analysis. By Prof. H. ter Meulen.

The usual methods for the estimation of sulphur, halogens, nitrogen, arsenic and mercury in organic compounds are based upon destructive oxidations. These determinations can be made quicker by using destructive hydrogenation, which enables us also to estimate oxygen. As a rule the substance that is to be analysed is heated in a quartz tuge through which a current of hydrogen is passed: in most cases katalysators are used to promote hydrogenation.

Sulphur is converted into hydrogen-sulphide, which is estimated by titration with solutions; if the amount of sulphur is very low (*e.g.*, in coal gas and oil), a colimetric method may be used. Halogens yield halogen acids, which are titrated by the method of Volhard. The nitrogen of organic compounds gives ammonia, which is also estimated volumetrically. Oxygen is changed into water that is weighed after absorption in calcium-chloride. Arsenic and mercury are both set free and weighed in metallic state.

The Development of the Calcareous Test of Echinocardium cordatum. By I. Gordon. Communicated by Prof. E. W. MacBride, F.R.S.

The complete development of the skeleton has been worked out from its earliest traces in the larva up to the adult condition. Bilateral symmetry is apparent almost from the beginning. The sub-anal fasciole is precociously developed in the larva. The ocular plates are only laid down after 8-10 ambulacral plates have appeared in each area. At metamorphosis the apical plates (genitals and oculars) are similar to those of a regular urchin, in occupying the centre of the dorsal surface and *surrounding* the periproct (anal membrane). Genital 5 (apparently absent in the adult) is present and arises from the *same larval spicule* as does genital 5 in *Echinus*. The backward shift of the periproct takes place very gradually, and genital 5, separated from the other genitals, remains as one of the plates in the adult periproct.

The modified "petal" of the anterior ambulacrum has simple plating in young forms (similar to that of an *adult spatangus*). The complex plating characteristic of the adult is only acquired at a comparatively late stage. In ambulacra II and IV only one colum is petaloid at first—a condition found, *e.g.*, in *Heteraster oblongus.* There is no trace of teeth or of the lantern ossicles ,but the perignithic girdle is represented by a single internal process. The membrane round the mouth is at first circular ,but soon becomes pentagonal and then gradually alters to the "reniform" outline of the ault peristome.

ON THE MALLEABLE CAST-IRON AND THE MECHANISM OF ITS GRAPHITIZATION.

By Tario Kikuta.

(*Tohoku Imperial University.*

In 1722, a French physicist, Réamur, obtained a white heart malleable cast-iron by heating white cast-iron surrounded by pulverised hematite powder at a high temperature for a long period of time. Later, in 1826, Seth Boyden, by using pig iron of a lower sulphur content containing a high percentage of manganese, instead of the high sulphur, low manganese material which had usually been employed up to and at his time ,obtained a black heart malleable cast-iron, which is now generally recognised as superior to the former in malleability. Though the art of making malleable cast-iron has developed a great deal since Réaumer's time, there has hardly been any theoretical work done on this subject, until quite recently many investi-

gations in this kind of casting having been made and the results published. They have, however, been either fragmentary or almost always confined to some special cases of the problem. In the course of the present investigation of the graphitization of white cast-iron, some important data have been published by Mr. H. Sawamura, Assistant Professor of the Kyôto Imperial University, who has also been engaged in the study of the same subject. He used a dilatometer, but the specimen, the dilation of which was measured by him, was cast in an iron mould 5 mm. in thickness, the temperature being raised at a constant rate, so that his results do not furnish us with any direct information regarding practical annealing in a cast iron foundry. A few years ago, the writer made a dilatometric study of the growth of gray cast-iron which occurs during repeated heating and cooling, and it was observed that the graphitisation of cementite in white cast-iron is distinctly proved to occur by the expansion accompanying such a reaction. The principal object of annealing a white iron is the graphitization of the cementite in it by virtue of which the conversion of a hard and brittle material to a soft and malleable one is effected. By using a dilatometer, measurements have been made of the amount of the grapitization which took place on keeping the test specimen at a constant high temperature, as is done in practice when annealing white cast-iron in the foundry, and the progressive degree of this reaction was checked microscopically afterwards. By using these methods, the writer has attempted to work out the theory of graphitization of white cast-iron, as well as to study the effects of annealing temperature, thickness of casting and the chemical composition of the material, etc., upon the graphitization.

SUMMARY.

The results of the present investigation may be summarised as follows :

1. The phenomenon of graphitization of white cast-iron has been thoroughly studied by means of a dilatometer.

2. In the investigation of graphitization of white cast-iron for obtaining black heart malleable cast-iron, it is desirable to carry out the graphitizatiou in two stages.

3. In order to graphitize white cast-iron completely, it is essential that after the completion of the graphitization of the free cementite at a high temperature above the A_1 point, the article should be heated just below the A_{r_1} point for a prolonged time or cooled very slowly from the A_{r_1} range to decompose the eutectoid cementite.

4. The graphitizations of the first and second stages are greatly affected by the annealing temperature, and the time required to complete them decreases logarithmically with the rise of temperature.

5. There is an intimate relation between the thickness of the casting and the size of the free cementite, *i.e.*, the size of the free cementite grows as its thickness increases; and the graphitization of the free cementite will become more difficult as its size becomes larger or the casting thicker.

6. The tapping temperature of the melt also affects the graphitization of white cast-iron, and the graphitization becomes more difficult as the temperature is raised.

7. Silicon has a powerful effect on the graphitization of the first and the second stages, and as this content is increased, the time required to complete the graphitization logarithmically decreases.

8. For the second stages of graphitization, carbon is more effective than silicon, although it hardly affects that of the first stage.

9. The action of manganese is to lessen the graphitization, the effect being particularly great on that of the second stage so that it is very important to limit its contents to below 0.5 per cent. in the case of the black heart malleable iron casting.

10. The action of sulphur is to hinder the graphitization like manganese, especially that of the second stage, and it is advisable to limit its content to 0.6 per cent. in practice.

11. Phosphorus acts in assisting the graphitization of the first stage, but for that of the second stage its content must not exceed 0.3 per cent.

12. From the results of the present investigation, some rapid heat-treatment of a practical sample has been tried and it was possible to obtain black heart malleable cast-iron by heating white cast-iron containing more than 2.5 per cent. of carbon and 1 per cent. of silicon for fifty-four hours.

13. The black heart malleable cast-iron makes a growth with repeated heating and cooling through the A_1 transformation range as grey cast-iron does; and the cause of this phenomenon is almost the same as in the case of grey cast-iron.

14. From the various phenomena studied in the present investigation, the following conclusion regarding the mechanism of the graphitization of white cast-iron is drawn :—By means of the catalytic

action of free carbon oxides present in the casting, a nucleus of the graphitizing temper carbon is formed principally along the boundary of the cementite, and the graphitization which is to take place successively, is accelerated by the affinity between the ion and the included elements.

KNOWNS AND UNKNOWNS IN THE THEORY OF DEVELOPMENT.

By S. E. SHEPPARD AND F. A. ELLIOT.
(*Eastman Kodak Abridged Scientific Publications.*)

In the study of photographic development three general methods of attack are notable :

1. The sensitometric or macroscopic method involves the study of the effects of the factors of time, temperature, stirring and developer constitution on the characteristic curve. The method is important at once for the light which it throws on the chemical dynamics of development and for its direct applicability to practical photographic problems.

2. The microscopic method : the statistical study of individual silver halide grains and of the effect of the various factors noted under (1) upon them.

3. The strictly physico-chemical method, the study of the molecular state of developer solutions and the minute mechanism of the reactions involved in the development process.

1. *Macroscopy of Development.*—The origin of the factor $1/t$ of Nietz' empirical expression for the rate of development,

$$\frac{dD}{dt} = \frac{K}{t}(D_{\infty} - D),$$

remains in doubt, the evidence for and against the "penetration" hypothesis being still contradictory. A large accumulation of data, notably that relating to the inhibitory influence of concentrated neutral salts on development rate and microscopic data proving that complete development of single-grain layer plates is effected in a short time, indicates that diffusion processes are the dominant factor in determining development rate. It is, on the other hand, impossible to dismiss as insignificant the factor of the relative reduction potential of the developing agent.

Sheppard and Meyer (*Phot. J.*, XLIV., 7, 1920), have modified the earlier theory of the mechanism of development which assumed reduction of silver ion in solution. The modified theory supposes that a selective adsorption of the reducing agent to the grain is the first step, forming an adsorption compound, probably a mono-molecular layer. Intramolecular rearrangement in this complex leads to break-down (internal oxidation and reduction), which is catalyzed by the "latent image" (nucleus) and by the first reduced silver. This theory, assuming as it does reaction in a condensed phase, accounts satisfactorily for the action of bromide and for the inhibitory effect of the vehicle and developer oxidation products upon development.

2. *Microscopy of Development.*—The extension by Svedberg, Toy, and others, of Hodgson's observation that the reduction of silver halide grains in development is initiated at randomly situated points, probably silver nuclei, and proceeds at the silver-silver halide interface, is perhaps the most important recent contribution to this branch of the subject.

3. *General Physical Chemistry.* — The primary criterion by which a reducing agent may be designated a photographic developer is the power of reducing light-activated silver halide, the so-called latent image, without affecting the unexposed halide. The latitude, in terms of reduction potential, thus permitted is sufficiently great to allow for an indefinite number of individual developing agents each of different reduction potential. The developing energy of any given alkaline developer is known to increase with the hydroxyl ion concentration, a fact which may be explained in three ways : (1) the active reducing agent may be assumed to be atomic hydrogen formed by reduction of water by the developer; the atomic hydrogen pressure which determines the reduction potential of the developer must be inversely proportional to the hydrogen ion concentration, and directly proportional to the hydroxyl ion concentration. (2) The active reducing agent may be considered to be the ionised anion of the developer proper. The concentration of the anion, and consequently the reduction potential of the developer, is then a function of the "strength" of the base, increasing with increasing hydroxyl ion concentration. In the case of certain developers such as the diamines this view becomes difficult of interpretation. (3) It is probable that the hydroxyl ion must be assumed to function

primarily by affecting the tautomeric equilibrium between two or more unequally active forms of the reducing agent. The more polar, the formation of which is favoured by a high hydroxyl ion concentration, will be preferentially adsorbed by the silver halide and then may reduce the latter to metallic silver by direct electron transfer or, by the inner shift of an electron, may furnish atomic hydrogen which reduces silver ion, a reaction which may conceivably be catalysed by the metallic silver nuclei. This last theory accounts satisfactorily for the low reduction potential and long induction periods of such developers as hydroquinone and p-phenylene diamine which are highly symmetrical in their polar forms and are hence less vigorously adsorbed than are developers into which an unbalancing substituent has been introduced.

Secondary or physical development may be considered as taking place through the formation of an addition compound between the complex silver ion radical and the reduced, which breaks down in the presence of silver nuclei. The process is not fundamentally different from the adsorption process outlines above.

ELECTRIC PRECIPITATION APPLIED TO GAS STREAMS.

By H. R. Hanley.

(*Missouri School of Mines.*)

January, 1926.

The smoke, dust and fume arising from metallurgical, cement, chemical and other industries, present a problem to be considered both from the standpoint of civic nuisance and from that of economic conservation.

The removal of suspended particles from gases by means of electric discharges was first suggested in 1824 by Hohlfeld, a teacher in the Thomas school at Leipzig, Germany. He found that if he electrified a wire hung in a bottle filled with smoke, the smoke cleared rapidly and a deposit formed on the sides and bottom of the bottle. About twenty-five years later this phenomenon was again called to public notice by Buitard of London. Sir Oliver Lodge brought up the subject of electric precipitation in a series of articles in 1884, 1885 and 1886. Karl Moeller, of Germany, experimented with electric precipitation of dust and fume and obtained a patent in Germany in 1884. No commercial application was made of his method. In 1906, Dr. F. G. Cottrell, when Professor of Physical Chemistry at the University of California, had occasion to repeat the experiments of Lodge while studying the removal of acid mists in the contact H_2SO_4 process. He became convinced of the possibilities of commercial application of electric precipitation and tests made at the Hercules Powder Works of the De Pont de Nemours Company at Pinole, California, 1906, demonstrated this fact conclusively. First commercial installation was made at the Selby Smelting and Lead Company on San Francisco Bay for the collection of H_2SO_4 fumes from parting kettles.

The Western Precipitation Company and the International Precipitation Company were organised for the purpose of administering the patent rights of the Cottrell process in domestic and foreign fields, respectively. In 1912 certain precipitation rights in the United States not controlled by the Western Precipitation Company were offered to the Smithsonian Institution. A separate organisation was incorporated for this purpose (inasmuch as the Smithsonian Institution could not conduct business activities), and was known as the Research Corporation of New York.

The electric precipitation of solids from gas streams when applied on a commercial scale is known as the "Cottrell Process," as it is due to Dr. Cottrell that this method, although previously known, was brought to bear upon the problem.

Brief Description.

The Cottrell Process as it exists to-day consists of passing the "smoke" or other gas stream to be cleared of its solids (or liquids) between electrodes whose difference in electric potential is very great. It has been found more economic to use a rectified alternating current rather than the usual alternating current. The conditioning of the electric energy may consist of sending an A.C. current through a step-up transformer, which delivers it at a very high potential to a revolving rectifier. This rectifier in turn delivers the electric energy in the form of an intermittent direct current at approximately the same potential as it was received. The "laboratory" of the Cottrell process, wherein the gases are treated, consists of a series of pipes with a wire in the centre of each, or a system of

plates in a flue with wires at suitable distance. The pipes or plates, depending upon which type is used, constitute the positive pole and the wires the negative pole. The rectified current at say 50,000 volts or more is now passed between these electrodes while the gas stream flows parallel with the length of pipe of flue which is at right angles to the path of the electric field. The velocity of the gases is controlled to the end that there will be provided sufficient time for the precipitation action to be fully effective before these gases are discharged. The successful precipitation of the solids is accomplished providing these deposits are conductive, or by virtue of some conductive gas in the stream condensing on the surface of the particles, they are rendered superficially conductive. A gas stream containing an excess of sulphuric acid over that required to combine with the oxides affords the most desirable conditions. If there is a deficiency of SO_3 in the stream this compound may be introduced artificially. If this method of causing conductivity is not found economical, the stream must otherwise be conditioned, as for example, the introduction of water vapour or steam. There are many other factors of importance which are inherent in the process, such as temperature of stream, percentage of solids, character of solids, *i.e.*, whether a fume or a physical solid is to be treated, etc. The knowledge of these factors and the proper regulation of the variables result in clearing the gas streams of the solids which may be recovered, and the valuable constituents subsequently reclaimed therefrom. The operation of the process then presents a twofold purpose, viz., the prevention of a nuisance which the dissemination of these solids might cause and the recovering of the valuable constituents present in the solids.

The discussion which follows will be principally confined to the fundamentals of the process in order to develop reasons for certain plant procedures.

Theoretical and Experimental Considerations.

The theory of electrical precipitation of suspended matter in gases and liquids is inseparably connected with the phenomena of ionisation, and the laws of electrically charged bodies.

The atmosphere near an electrically charged body becomes an electrostatic field. When a pith ball is brought near this charged body it is influenced by this field and receives positive and negative charges of electricity. The pith ball will move in one way or another, depending upon the polarity of the charged body. This movement occasioned by attraction or repulsion of unlike or like charges respectively takes place in an electrostatic field where the flow of electric current is practically zero.

There is more or less freedom with which these charges may be detached from the pith ball.

The laboratory of the Cottrell process is an atmosphere of intense electrification due to a great difference in potential between the electrodes. The particles of smoke, fume and dust are extremely minute relative to the size of the pith ball mentioned, and are very numerous. These particles receive charges in a different manner than do the large pith ball. The large difference in potential between the electrodes causes a corona current to flow in the field. There are certain essential phenomena characteristic of this corona current which causes the charging of the particles in the gas stream. In this we are concerned with the surge of electrons emanating from the negative electrode.

The polarisation of the pith ball is a manifestation of the phenomena which occur in the splitting up of the atoms into their electronic components.

This analogy is helpful in getting a perspective of events occurring in the electric field; but the cause of the charge, the structure of matter, the electronic migration and ionisation agents should be given due consideration at the start.

The suspended particles in a gaseous medium when subjected to the action of intense electric field, become charged by the action of the travelling electrons and consequently tend to travel with these electronic streams.

Atomic Structure.

The atomic theory of matter is useful but is for the classification of elements. The concept of definite and indivisible atoms, of different weights could not be the *ultimate* solution of the problem of material structure. It provides no answer to a variety of problems. The difference in chemical properties between two atoms, say hydrogen and oxygen, can never be explained by the simple difference in weight. The varying valence of the different elements and also the varying valences of a single element

remain entirely unexplained on the basis of the simple atomic theory. The spectral differences among the elements are likewise unexplainable.

The similarity and periodicity of properties, both physical and chemical, is strong evidence that similar elements must possess similarities of architecture not shown by a theory of indivisible atoms.

The Electron.

Faraday's experiments on the conduction of salt solutions are the first experiments indicative of accurate units of electricity. Faraday's law may be expressed as follows:

"For every chemical bond which is ruptured within an electrolyte a certain quantity of electricity traverses the electrolyte which is the same in all cases.'

The most startling result of Faraday's law is this, if we accept the hypothesis that elementary substances are composed of atoms, we cannot avoid concluding that electricity also, positive as well as negative, is divided into definite elementary portions, which behave like atoms of electricity.

Faraday's law was not sufficient to establish the atomic concept of electricity. It applied to solutions of electrolytes. The proof of atomic electricity did not come until mechanism of gaseous conduction had been studied and the properties of gases acted upon by X-radiation and radio active *materials had become familiar.* Gases treated with X-rays were found to be conducting. The conductivity thus induced in a gas was caused by an agency which could be removed by:

1. Filtration through glass wool.
2. By passage through metal tubes or between plates maintained at sufficiently large potential differences.

The conductivity was therefore due to electrically charged particles.

More detailed knowledge of the nature of charged particles was obtained by the study of the conduction of electricity through gases at low partial pressures. When currents at high potentials are discharged through gases about 0.01 mm. or lower, charged particles or corpuscles are shot off from the cathode. These particles were first investigated by Sir William Crookes, and called by him the "fourth state of matter" (*Chemical News*, XLI., 275). They have properties, the sudy of which led to an appreciation of their significance in *atomic structure.*

The cathode particles were shown to have the following properties:

1. "They travel in straight lines normal to the cathode and cast shadows on an opaque object placed in their paths.
2. They are capable of producing mechanical motion.
3. They produce phosphoresence in many objects exposed to their action (example—blue phosphoresence in lead glass).
4. They produce rise in temperature in objects they strike.
5. They may be deflected, by electromagnetic and electrostatic fields from their normal rectilinear paths.
6. The charge carried by the particle is negative since they electrify negatively insulated metallic electrodes upon which they fall.
7. They may penetrate thin sheets of metal, the stopping power of the metal varying directly with the thickness of the metal and with its density.
8. They act as nuclei for condensation of supersaturated vapours. The fogs thus formed are useful as a means of rendering the particles visible.
9. The particles are identical in nature and in the ratio of charge carried to the mass of the particles, *independent of the nature of the residual gas in the discharge tube, and of the electrodes used.* This represented the first definite indication that the cathode particles were a common constituent of all atoms.

Our modern theory, therefore, includes the statement that charges of electricity are composed of the so-called electrical atoms, each one of which is made up of the same quantity of electricity. The molecules of all material substances, whether gases or liquids, when in their neutral state, obviously possess equal quantities of positive and negative electricity. There is no evidence of the existence in atoms of any particles other than these two.

(*To be Continued Next Week.*)

New Patents.

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Latest Patent Applications.

22,655.—O. G. Farbenindustrie Akt-Ges. —Manufacture of azo-dyestuffs. September 14th

22,56.—Ermen, W. F. A. Manufacture of vat dyes. September 13th.

23,003.—Hayhurst, W. Pumps for acids etc. September 17th.

23,061.—Higgins, E. B.—Processes for carrying out chemical reactions at high temperatures. September 18th.

22,985.—I. G. Farbenindustrie Akt-Ges. Dyeing cellulose esters, etc. September 17th.

Specifications Published.

257,689.—Blackburn, H. W., & Thomas, W.—Manufacture of ammonia.

257,968.—Dreyfus, H.—Manufacture of acetic anhydride.

257,991.—Soc. of Chemical Industry in Basle.—Preparations of dyestuffs.

235,588.—Buchner ,M.—Process of producing hydroxides and carbonates.

258,020.—Mallabar, H. J.—Manufacture of cellulose acetate.

Printed Copies of the full Published Specification may be obtained from the Patent Office, 25 ,Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

Abstract Published.

255,925.—Photographic developers. — Schestakoff, P., and Merejkovsky, B., 4, Passage Jean-Nicot, Paris.

To rectify errors in exposure ordinary developing compositions have added thereto hydroxylamine sulphonic acids or nitrilosulphonic acid, or salts thereof. As an example hydroxylamine isodisulphonate of soda (5 grms.) is added to a developer comprising hydroquinone (5 grms.), sulphite of soda (20 grms.), carbonate of soda (40 grms.), bromide of potassum (1 grm.), and water (1000 grms.).

255,434.—Synthetic drugs. — Chemische Fabrik Auf Actien, Vorm. E. Schering, 170, Mullerstrasse, Berlin.

Pyrazolone-barbituric acid compounds. Double compounds of dialkylbarbituric acids and dimethylaminophenyldimethylpyrazolone are prepared by melting the components together and cooling them, both operations being effected in an atmosphere of an inert gas, such as carbon dioxide, hydrogen, and nitrogen. By the exclusion of air, colourless products are obtained. An example is given of the preparation of the pyrazolone compound of diethylbarbituric acid in a vessel through which carbon dioxide is passed before and during the melting operations.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks **Journal, and is Published by** permission of the Controller of His **Majesty's Stationery Office.**

KENTOX.

471,461.—A disinfectant. — Abol, Ltd., Beltring, Paddock Wood, Kent. September 22nd.

BATICOL.

472,332.—Chemical substances used for agricultural, horticultural, veterinary and sanitary purposes.—La Societe Dionysienne de Produits Chimiques, 8, Rue des Ursulines, St. Denis (Seine), France. September 22nd.

MELVET.

471,994.—Chemical substances prepared for use in medicine and pharmacy.—Percy Cooper Luty, 72, Balmoral Avenue, Cathcart, Glasgow. September 22ud.

PERTAB.

472,005.—Chemical substances prepared for use in medicine and pharmacy.—Oesterreichische Chemische Werke, V/1, Technikerstrasse 5, Vienna, Austria. September 22nd.

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RECENT INVESTIGATIONS ON THE ELEMENTS MASURIUM & RHENIUM.

By WILHELM AND IDA NODDACK.

(Translated from *Die Metallbörse-Chemisch-Metallurgische Zeitschrift*, 1926, XVI., 2129; September 22.)

A year ago we recorded in this journal that working in conjunction with O. Berg we had found two new elements of atomic numbers 43 and 75.

We foreshadowed the chemical and physical properties of these two hitherto unknown elements and upon this we worked on the preparation of a material rich in them. In this way a large number of minerals were treated and had the result that the presence of the new elements, 43 and 75, was proved by X-ray analysis in the final products from the working up of columbites and similar minerals. We chose the names Masurium for 43 and Rhenium for 75. We have continued our chemical researches on these elements. The X-ray work has been carried out by Drs. Berg and Beuthe at Siemens and Halske's works. We propose to describe here the methods used in extracting the end products containing the manganese homologues. As starting material Norwegian columbite was almost exclusively used. It is an iron niobate of the formula $Fe(NbO_3)_2$. The Fe is partly displaced by Mn and the Nb by Ta. The mineral also contains a large number of other elements, *e.g.*, those usually in amounts up to 1-5%, Be, Al, Ti, Zr, Si; 0.1-1%, Sc, Yt, and other (rare) earths, Hf, Th, Va, Cr, Mo, W, Ur, Co, Ni, Cu, Zn, As, Sn, Pb; and traces (0.001-0.1%) Pt, Ir, Ag, Au, Cd, Ga, In, Tl, Ge, Sb, Bi. It can thus be said that almost all the known elements in the Periodic System have been shown to occur in columbites and similar ores. This occurrence together of so many bodies makes the working up of the mineral extraordinarily difficult in the direction of isolating both new bodies, which occur in such small amounts, since their chemical reactions would be changed or easily concealed by the excessive concentration of so many other elements. On this basis, the X-ray work becomes of high value as the presence of other bodies does not have this influence upon the detection of these elements.

The working up of the minerals was carried out as follows. Finely powdered columbite (1-20 kg.) was heated with NaOH and $NaNO_3$; Fe and the earths form insoluble oxides. Nb, Ta, and many other elements form water soluble Na-salts, but on extracting with water much niobate and tantalate remains, with Fe, insoluble in concentrated alkali in which their sodium salts are only soluble with difficulty. The Mn which remains in solution as Na_2MnO_4 is easily removed by H_2O_2. The solution, coloured yellow by chromate, contains chiefly Nb, Ta, Mo, and W and almost all the masurium and rhenium (as Na-salts) that were in the columbite. This solution was first saturated with H_2S and acidified and the precipitated sulphides were separated. This was repeated many times since even after two precipitations and acidifyings much W, Pt and Ge remained in solution. In our earlier procedure the residues after evaporation were combined with the five or six sulphide precipitates.

The sulphide so separating contained—

Nb and Ta	80%
Ti, Zr and Hf	10%
Fe, Co, Ni and Mn	5%
W, Sn and Mo	4%
Traces of Cu, Zn ,Bi, Pb, Ge, As, Cd, Va together about	1%

Elements such as Fe and Mn occur in the precipitate since traces pass through the filter as colloids. In the alkaline sulphide precititating and re-acidifying ,sulphides of W and Mo come down as well as during the separation of niobic acid, for these bodies cannot be washed out from it.

The amount of sulphides so precipitated from 1 kg. of columbite was about 0.5-5 gr. In a few cases the occurrence of 43 in the preparations could be shown by X-ray analysis by the appearance of the $K\alpha_1$ line of 43, but it was generally necessary for a further treatment before the Mn homologues could be detected. The next process consisted in the removal of the excessive amounts of niobic and tantalic acids. The precipitates were treated with *aqua regia* in distilling flasks and the solution of the residue filtered from most of the acidic earths and also W which remained insoluble. The Mn homologues were not found in the distillate. They therefore remained completely in the *aqua regia* solution which was evaporated to dryness on a water-bath, treated with $(NH_4)_2S$ and further evaporated and the residue reduced in a stream of hydrogen. The weight after the reduction was 0.05-0.5 gr. per kg. The X-ray spectrum showed the $K\alpha_1$ and $L\alpha_1$ (weakly) of 43. The composition of this preparation was :

Fe, Co, Ni, and Mn	60%
Nb, Ta, Ti, Zr, and Hf	5%
Sn and Mo	25%
W, Cu, Zn, Bi, Pb, Ge, As, Cd, Va	10%
Ma	.05-.1%
Re	.05-.1%

Treatment with alkali removed most of the Fe, Co, Ni, Mn, the acid earths, Sn and Cu. From the filtrate addition of acid precipitated the sulphides insoluble in acids, *e.g.*, Mo, Va, Pb, Pt, Ge, As, and a very little Nb and Ta as well as Re and Ma. As the sulphides of the latter should be very slightly soluble in cold $(NH_4)_2S$. The residue was treated with a little cold $(NH_4)_2S$. The residue, 0.002-0.02 gr.) had an average composition : Pb, 50% ; Mo, 30 ; Va, 10 ; Pt, 5 ; W, 1 ; Zn, 0.5-2 ; Nb, 2 ; Ta, 0.1-.5 ; Ma, 0.2-1 ; Re, 1-5.

This product showed 1-3 lines of Ma, $K\alpha_1$, $K\alpha_2$, $K\beta_1$, and 2-5 lines of Re, $L\alpha_1$, $L\alpha_2$, $L\beta_1$, $L\beta_2$ $L\beta_3$.

For the preparation of pure Mn homologues the final products have so far been too small. As we have already stated, 1,000 kg. of columbite is needed, an amount which has made it up to now financially impossible in spite of considerable efforts.

On the other hand, the facts show that the concentration should follow along the lines of our foreshadowings and it has been possible for us to show that the proof of the existence of these two new elements can be reproduced.

Further, we have enriched Ma by many precipitations with alkaline NH_4Cl from the W-Mo fraction, and thereby separated Re. The optical spectrum of the mixture plainly shows 43 or 75, and a number of the arc and spark spectrum lines must be ascribed to these elements. The solution of the end products showed a series of reactions. An oxide or oxy-chloride of Re is soluble in ether and the oxide of Re sublimes like MoO_3. The salts show no pronounced colour in water and are either white or perhaps light yellow. The solubility of the sulphide in $(NH_4)_2S$ is very slight.

In the course of last year several other works appeared dealing with the question of the Mn homologues. In the first place, Druce states (*Chem. News*, 1925, CXXXI., 273), that following our methods he obtained 1 gr. of the oxide of 75 from Mn minerals, and recognising our priority called it rhenium. We cannot clearly understand the procedure or the results. It is extraordinary that so large a quantity as 1 gr. of 75 should be obtained from 400 gr. of so well known a metal as Mn. He precipitated the Mn solutions with H_2S till no more MnS separated, filtered, evaporated the solution, dissolved in acetic acid and precipitated the Ca as oxalate. The filtrate was evaporated, ignited and the residue, dissolved in HCl and precipitated with ammonia. This precipitated product

should be the hydroxide of 75. All the properties Druce gives, *e.g.*, solubility in acids, gradual darkening of the hydroxide, the green, easily decomposed solution of the product of fusion with alkali are possessed by Mn; also its atomic weight estimation by passing from a higher oxide to a lower gives the atomic weight of Mn when the process is conceived not as DO_3 to DO, but as MnO_2 to Mn_2O_3. Further, the X-ray plate shows the 75 $L\alpha_1$ and $L\beta_1$ lines and also th *K* lines of Fe and Mn. This shows his material was not Mn free but Mn contaminated with Fe, which would explain the chemical reactions. The so-called 75 $L\alpha_1$ line must be Zn $K\alpha$ for his spectrograph had far too small a dispersion to distinguish between 75 $L\alpha_1$ and Zn $K\alpha_1$. The so-called 75 $L\beta_1$ must also be Hg $L\alpha_1$, so that both by chemical and physical methods it is seen that Druce had only a trace of 75 in his preparations.

Following on this Heyrovsky and Dolejsek state that they observe two kinks in the deposition curves on the polarographs of the electrolysis of Mn solutions. These they ascribe to Mn homologues.

Heyrovsky and Dolejsek mention many cases in which element 75 occurs in Mn to a concentration of 10^{-5} to 10^{-4}. It is noteworthy that with Mn salts as starting material which should contain 0.001-0.01% of 75, they finally have a solution of 6 mg. of $MnCl_2$ which is said to contain 1.5% of 75. We have examined 1-10 kg. of the same starting material, from the same source as Druce and Heyrovsky and Dolejsek, but have not found any indication of the occurrence of 75 either by their or our methods. They state they have found the 75 $L\alpha_1$ and $L\beta_1$. 75 $L\alpha_1$ cannot be separated from Zn $K\alpha_1$. The line we say is 75 $L\alpha_1$ they say is a new zinc line—a new thing in X-ray spectra! Unfortunately, Heyrovsky and Dolejsek do not supply the proof why another Zn line should appear.

They measure their wave-lengths to the last decimal to an extent that their apparatus could not measure. Their 75 $L\beta_1$ could well be Hg $L\alpha_1$ and their 75 $L\beta_2$ also Tl $L\alpha_1$ since Tl often occurs in Mn salts.

The chemical properties they give are equally those of Mn and 75 as an element which stands between W and Os. Heyrovsky and Dolejsek have in our opinion given no evidence that they have come across 75 and this is supported by the fact that in spite of the easily prepared starting material and simple methods of extraction they have not been able to give any property which belongs to element 75.

In conclusion, let us consider the work of W. Prandtl. On the basis of our publications, Prandtl has tried to enrich the eka-manganese and dvi-manganese in two sorts of columbite and to show their presence by X-ray analysis. This experiment failed. Final preparations of 1 gr. (from 1 kg. of starting material) showed no trace of 43 or 75. According to the above-mentioned method of enrichment, his result does not appear astonishing for in end-products of a mass of 1/1000 of the starting material, proof of the presence of eka- and dvi-manganese only succeeds in favourable circumstances. We do not doubt that Prandtl, in further enrichment in the same manner, would be able to prove the presence of Ma and Re in columbite.

Prandtl mentions further that he could not prove the presence of Re in one of our preparations of this element sent at his request. His research on the confirmation of our results is indeed welcome, but he does not reach, by far, a conclusion by examining one columbite, whether it contained eka- and dvi-manganese or not, still less, to refute our positive results from about 10 columbites.

Since the isolation of the eka- and dvi-manganese is only a question of money, and we await early assistance in our researches, we hope in a short interval to be able to record the properties of the pure elements masurium and rhenium.

THE SOLID HYDRIDES OF BISMUTH AND TIN.

A Reply to Strecker and Daniels.
By J. G. F. Druce and E. J. Weeks.

W. Strecker and W. Daniels have just published a criticism, Uber die Bi- und Sn-Hydride von Weeks und Druce, *Ber.*, 1926, LIX., 1691), of our work on the solid hydrides of bismuth and tin (Bismuth dihydride, *J. Chem. Soc.*, 1925, CXXVII., 1799; Bismuth Trihydride and Silver Bismuthide, *Nature*, 1925, CXVI., 710; Les Hydrures Solides d'Arsenic, d'Antimoine et de Bismuth, *Rec. trav. chim.*, 1925, XLIV., 970; see also *Chem. News*, 1924, CXXIX.,

31. The first reference to our work given by Strecker and Daniels—*J. Chem. Soc.*, 1925, CXXVII., 1069—is to a paper on antimony dihydride, but they make no mention of this substance in their criticism.

In the course of their paper they point out from analogies in the Periodic Classification that bismuth should not form a solid hydride. In view of this they doubted our results and repeated our work. They obtained, by the action of zinc and hydrochloric acid on bismuth chloride, a dark grey voluminous mass which was free from zinc.

From it they were, however, unable to obtain as much gas (hydrogen)as is required if the compound has the formula, Bi_2H_2, which we had assigned to it. They describe an apparatus for measuring directly the amount of gas evolved and from their work they concluded that in our experiments we had driven off occluded hydrogen, or air, when we heated *in vacuo*.

Neither could they confirm the formation of bismuth trihydride when the dihydride is heated in a stream of hydrogen. They state that when the issuing gas was passed into an ammoniacal solution of silver nitrate, they obtained a precipitate which consisted of Ag_2O, $NHAg_2$ and NAg_3. Their precipitate contained no bismuth and could also be obtained by passing hydrogen alone through ammoniacal silver nitrate.

Finally, they state that they were unable to obtain tin dihydride, Sn_2H_2, possessing the properties ascribed to it (Weeks, Tin Dihydride and Tin Tetrahydride, *Rec. trav. chim.*, 1926, XLV., 201).

No proof is given by the German authors that they have obtained the oxide, imide and nitride of silver, but we were able to show by analysis that our precipitate, obtained by passing bismuth trihydride (mixed with a large excess of hydrogen, it is true) into ammoniacal silver nitrate was silver bismuthide. Further proof of the formation of some bismuth trihydride by the action of hot hydrogen upon the dihydride is forthcoming in the fact that when the issuing gas is passed through a strongly heated tube, a mirror of the metal is deposited just beyond the heated part. This is similar to the behaviour of arsine and stibine.

The German authors give no account of the physical and chemical properties of their products so that we are unable to decide whether they were dealing with the same substances as we obtained. We believe they did not isolate the same compounds as we had studied for the hydrogen estimations by our "vacuum" method corresponded within the limits of experimental error with the hydrogen estimated by combustion. (Weeks, "The Reliability of Vacuum Analysis for Solid Metallic Hydrides, *Chem. News*, 1926, CXXXII., 17).

That hydrogen is contained in bismuth dihydride can be shown by gently decomposing the substance *in vacuo* and exploding the gas after admitting air. All our solid dihydrides, when gently heated, ignited and glowed throughout the whole mass. It would be of interest to know if Strecker and Daniels' preparation showed the same phenomenon, which hardly suggests that the hydrogen is occluded in these cases. Whether the gas is occluded or not is, perhaps difficult to say, but since the hydrogen content of a number of preparations is constant and agrees with the constitution, Bi_2H_2, we are inclined to believe our compound has this formula and is bismuth dihydride, which Strecker and Daniels do not appear to have obtained.

Battersea Grammar School,
St. John's Hill, S.W.11.
October 4, 1926.

General Notes.

BOARD OF TRADE ANNOUNCEMENT.

EXPORT OF PITCH PROHIBITED.

The Board of Trade have issued the following Order, dated 5 October, prohibiting the export of Pitch :

The Board of Trade, in exercise of the powers conferred upon them by the Emergency Regulations (No. 6) 1926 and of all other powers enabling them in that behalf, hereby order as follows :—

1. The shipment of pitch for exportation, except under such conditions as the Board of Trade may by their licence allow, is hereby prohibited.

2. This Order may be cited as the Pitch (Emergency: Prohibition of Export) Order, 1926.

Copies of the Order may be purchased from H.M. Stationery Office.

BRITISH FILM PRODUCTION.

THE NEED FOR A QUOTA.

In December, 1925, the Federation of British Industries, in conjunction with other National organisations, laid before the Board of Trade a proposal in the form of a draft Parliamentary Bill for the introduction of a system (involving both the renter and the exhibitor) for the compulsory showing of a steadily increasing proportion of British pictures. Nothing has occurred since then to modify the view of the Federation that action on these lines is essential for the restoration of British production.

GEOLOGICAL WORK ON BAFFIN ISLAND.

The High Commissioner for Canada in London has received from the Dominion Department of Mines at Ottawa the following article prepared by Mr. Wyatt Malcolm, of the Geological Suvrey Branch :—

" Baffin island, which lies immediately to the north of the route to Hudson's Bay, is at present a field of investigation by the Geological Survey of Canada. Dr. L. J. Weeks and an assistant were landed during the summer on this island from the Canadian Government boat making its annual trip to the established posts in the Arctic. They will remain during the winter and carry on a geological survey of the southern part of the island.

Baffin island is the largest and probably the most important of the Arctic islands. It has an area of 211,000 square miles. Observations made along the part of the coast that has been explored show that it is underlain by rocks of Precambrian and Palæozoic age and to less extent probably by Tertiary sediments. A small tonnage of graphite and mica has been shipped from the southern part of the island, and at Ponds Inlet in the northern part a small quantity of coal is mined.

SIR JOHN CASS TECHNICAL INSTITUTE.

The 25th session of the work of the Sir John Cass Technical Institute was inaugurated on October 4, on which occasion an address was delivered by Alderman Sir Charles Wakefield, Bt., C.B.E., to whom students, who had gained special successes during the previous session ,were presented.

Before calling upon Sir Charles to deliver the inaugural address the Chairman of the Governors, the Rev. J. F. Marr, referred to the resignation of Dr. Keane, who had been Principal for almost a quarter of a century, the appointment of Mr. George Patchin, A.R.S.M., M.I.M.M., as his successor, the generous support given to the work by the important companies connected with the Fermentation and Petroleum Industries, and the gratifying record of University successes. In the latter connection, attention was drawn to the fact that the degree of D.Sc. had been conferred on one of the students as a result of a thesis based on research work carried out in the department of Chemistry. Particular mention was also made of the further facilities for study which are being provided during the session, including a more advanced course of lectures in colloids, a series of lectures on the Retail Management of Beverages and Refreshments, and an advanced course of lectures on Petroleum Technology, the latter embracing special lectures on Petroleum Colloids.

During his address, Sir Charles said he thought that during the last few decades the social factors that disincline young men and women to serious study have more than kept pace with the development of educational facilities. Cultural impulses have to contend with innumerable opportunities for pleasurable time-wasting and without doubt millions of foot-pounds of intellectual energy have been expended on cross-word puzzles and competitions evolved by ingenious pressmen to-day. In any age the student has to be made of stern stuff, but in view of the innumerable distractions that tempt to pleasure-seeking, the student of to-day must be something of a hero, possessed of an exceptional degree of wisdom, strength of mind and self control. Success, according to Sir Charles, lies not in the grasping of all that is desirable in material wealth, but rather in complete

development of all the finest elements of the individual character. This definition does not bar a reasonable degree of material success and happily, real creative success in business generally means the enlargement of wealth and opportunity for thousands of other men and women.

THE ROYAL SANITARY INSTITUTE.

Health Exhibition at Hastings, July, 1927.

In connection with the 38th Congress of the above Institute, a Health Exhibition is to be held at Hastings from July 11 to July 16, 1927. Particulars as to space, etc., can be obtained from the Curator of the Exhibition, Mr. C. J. Kilgallin, or the Institute Secretary, 90, Buckingham Palace Road, London, S.W.1.

WILD-BARFIELD ELECTRIC FURNACES.

Our attention has been called to the fact that the above have been on the market for seven or eight years, and have, on merit, commanded pretty widespread approval.

BOARD OF TRADE ANNOUNCEMENT.

Dyestuffs (Import Regulation) Act 1920.

Applications for Licences in September, 1926.

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during September, has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee.

The total number of applications received during the month was 546 ,of which 497 were from merchants or importers. To these should be added 22 cases outstanding on the 31st August, making a total for the month of 568.

These were dealt with as follows :—

Granted—489 (of which 465 were dealt with within 7 days of receipt).

Referred to British Makers of similar products—62 (of which 47 were dealt with within 7 days of receipt).

Referred to Reparation Supplies available—9 (all of which were dealt with within 2 days of receipt).

Outstanding on 30 September ,1926—9.

Of the total of 568 applications received, 521, or 92 per cent., were dealt with within 7 days of receipt.

AMERICAN PROHIBITION.

In his book, "Prohibition at Its Worst," published recently by the Macmillan Company, Irving Fisher ,Professor of Economics at Yale, declares that "evidently Constitutional Prohibition came on the country somewhat prematurely." But he adds that "after an examination of all the data, I have estimated that the flow of alcohol down human throats in the United States is at present cerainly less than 16 per cent., probably less than 10 per cent., and possibly less than 5 per cent. of the pre-prohibition consumption." For this reason, and because of new facts set forth in the book tending to show that new recruits to the army of drunkards are slackening among the young first offenders, Professor Fisher urges that the experiment be continued.

In his eyewitness story as Chairman of the War-time Conference on Alcohol of the of the Council of National Defence, Professor Fisher states that the limited trial period of prohibition during war time and one year thereafter, which his committee had recommended, was finally passed only after Congress had voted to submit the Eighteenth Amendment for ratification by the States. In fact, war-time prohibition did not take effect until after the war was over, and then served merely as a stop-gap between the adoption of Constitutional prohibition and its taking effect permanently.

"During the last six years in which America has been under national prohibition, its imposition by the Eighteenth Amendment and the Volstead Act have won distinguished foes. The Moderation League, which presented to the Senatorial Subcommittee on the Judiciary in Washington during April, 1926, A National Survey of Conditions Under Prohibitions ,1925, unlike earlier societies opposed to measures prohibiting or restricting the liquor traffic, is not made up of brewers and distillers. However they might unwittingly be subjected to the influences of the brewers, and, as I shall show later, be used in their interest, the eminent gentlemen of the Moderation League are personally above reproach.

"The Association Against the Prohibition Amendment and the Moderation League, tell us to 'face the facts.' To be mentally honest, we must frankly face all the facts. Some of these are not pleasant for Prohibitionists to face; others are not

pleasant for its opponents. There seem to me to be nine great facts, or groups of facts, to face. These constitute the outline of this book :—

1. The present situation of imperfect enforcement is intolerable.

2. Conditions are not, however, as bad as commonly represented.

3. Prohibition has accomplished much good hygienically, economically and socially.

4. The "personal liberty" argument is largely illusory.

5. We cannot accomplish what the opponents of prohibition really want by amending the Volstead Act, without thereby violating the Eighteenth Amendment.

6. To repeal the Eighteenth Amendment is out of the question.

7. To nullify it would mean disrespect for law of the most demoralising kind.

8. Therefore the only practicable solution is to enforce the law.

9. Enforcement is a practical possibility.

"I shall take up these nine points in their order. As to the first point, that is, the seriousness of the present situation, I have nothing to add to what the Moderation League presented in its summing up before the Senate Sub-committee on the Judiciary, together with such facts as were brought before the sub-committee as to defects in law enforcement. These were presented by Federal District Attorney Emory R. Buckner, Senator William C. Bruce, of Maryland, Senator Edge of New Jersey, and others. When referred to these facts will not be scanted.

How Much Alcohol is Really Consumed?

"Mr. Emory R. Buckner, United States District Attorney in New York, presented estimates at the sub-committee hearings in Washington, purporting to show that the diversion of industrial alcohol probably reached 60,000,000 gallons a year. This was unexpected, and, of course, good 'news' for the press.

"Dr. J. M. Doren, Chief Chemist of the Bureau of Internal Revenue and in charge of the department dealing with this phase of the situation, presented a most excellent and elaborate analysis of Buckner's erroneous reasoning, and also a study showing the diversion of industrial alcohol for brewing purposes to be between ten and fifteen million gallons a year, and probably between thirteen and fourteen million, or only 8 to 9 per cent. of the pre-war consumption of beverage alcohol.

"It must also be remembered that not all of the alcohol diverted is consumed. Between one and two million gallons have been recaptured and confiscated. Leakage, breakage, and evaporation will account for almost as much more. The result is that probably illegal consumption of alcohol from diverted industrial alcohol is less than 8 per cent. of pre-prohibition consumption, legal and illegal.

"To this must, of course, be added the alcohol smuggled into the country and distilled or brewed absolutely; but all experts agree that all put together, they constitute a minor part of illegal liquor, far less than that from diversion of industrial alcohol, that is, far less than 8 per cent. of pre-prohibition consumption.

"After an examination of all the data, I have estimated that the flow of alcohol down human throats in the United States is at present certainly less than 16 jer cent., probably less than 10 per cent., and possibly less than 5 per cent. of pre-prohibition consumption.

"An entirely independent estimate has been made by Coradini. This is based on the assumption that the samples seized by the Treasury Department represent a true cross-section of the liquor on the market, of which the legal portion is known.

"This calculation has not yet been published; but all experts who have seen it can find no serious flaw in it, except the possibility that the samples seized are not representative. Corradini's result indicates that the total consumption is less than 3 per cent. of preprohibition consumption!

"It seems safe to conclude that the total consumption to-day is probably not over one-tenth of pre-prohibition consumption."

BACK TO DR. SUNSHINE.

M.O.H. Prescribes the Perfect New House.

"New houses should not be built with smoky, extravagant coal ranges and coal fires," declared Dr. C. S. Thomson, Medical Officer of Health for Deptford, speaking at the Borough Hall, Deptford, on Wednesday evening (October 6) in connection with the local Health Week movement.

Dr. Thomsan declared that the smoke evil was the greatest enemy of city dwellers, and that domestic smoke was greater in quantity and more harmful in quality than factory smoke. It was estimated that smoke caused one million pounds' worth of damage every year in

Manchester and four million pounds' worth in London.

It was curious that some years ago a Departmental Committee on Smoke recommended that no building scheme should be sanctioned unless provision was made for the adoption of smokeless methods, except where the central authority thought it impracticable. Unfortunately, plans had since been passed perpetuating the old features.

"The fact is that the open kitchen range is out of date," said Dr. Thomson. "It not only wastes coal and causes smoke, but its efficiency is only 7 per cent. of what it should be. The back boiler behind the kitchen range is very wasteful of coal and does not provide enough water for hot baths. Cooking by gas is far better than by the kitchen range. The Government, the local authorities, and pricate builders must provide houses from the point of view of fuel economy and smokelessness."

Prescribing the heating arrangements for new houses, Dr. Thomson said that they should have one coal grate of small fuel capacity, fitted with draught regulators, and there should be gas fires in the other rooms of the house. as, for intermittent use, was cheaper and handier than coal fires.

Dealing with the town planning question, Dr. Thomson said new houses should enable people to live under conditions of health, both physical and mental, affording means of reasonable recreation and enjoyment. Areas should be planned in open formation. Pleasant surroundings were wanted with more space and more scope for recreation. arden suburbs led to beneficial effects on health and happiness. People would then get back to Dr. Sunshine.

NEW HEADMASTER AT ELLESMERE COLLEGE.

The Provost and Fellows of Denstone (the Midland Woodward Society) have elected the Rev. A. V. Billen ,M.A., Oxon., Ph.D., and B.D., London, to the Headmastership of S. Oswald's School, Ellesmere, in succession to the Rev. T. H. Hedworth, lately preferred by the Lord Chancellor to the Rectory of Wellesbourne, Warwick.

Dr. Billen has had a very distinguished career. He was an Open Scholar of University College, Oxford, where he took a double First in Mathematics (Moderations and Finals), having gained the Junior and Senior University Scholarships in the same subject. He afterwards took the degrees of Bachelor of Divinity and Doctor of Philosophy in the University of London. Dr. Billen has been for the last nine years Senior Mathematical Master at Leeds Grammar School, where he has also acted as Chaplain and Honsemaster. In conjunction with the Professor of Mathematics of Leeds University, Dr. Billen helped to found the Yorkshire Branch of the Mathematical Association of Yorkshire, of which he is Vice-President.

Mrs. Billen has taken an active interest in the school life and in the public life of the City of Leeds, and in the War had much experience in the organisation and working of a V.A.D. hospital.

Dr. Billen will take up the Headmastership of S. Oswald's School in January next.

A SHORT ACCOUNT OF THE CHEMISTRY OF THE STEROL GROUP.

By F. William Fox, D.Sc., A.R.C.S.

The story of the sterol group, like so many byways in organic chemistry, began with the study of a solitary snbstance—in this case the main constituent of gallstones —and has led to the discovery of quite a numerous and remarkably widespread group of substances.

Cholesterol, which may be taken as the typical member of the group, was, in fact, one of the earliest biochemical substances investigated, being examined by Poulleton de la Sage in 1770, and again a few years later by Fourcroy. The name, signifying solid bile, is due to Chevreul (1810), who was the first to realise something of its true nature. Since then its chemical nature and its place in the animal economy has been the subject of persistent bnt to a certain extent rather fruitless inquiry.

It is a white, highly crystalline substance, M.P. = 148.5, a = - 29.9. In common with other members of the group, it exhibits several curious properties, snch as the tendency to form liquid crystals, marked power of forming stable emulsions, and a propensity for producing crystalline mixtures which are most difficult to resolve. Chemically it is characterised by its inertness and its resistance to the action of strong alkali; on the other hand, a number of strongly marked colour reactions are given

with suitable reagents. Though seldom met with in more than small amounts, it is of widespread occurrence in the animal kingdom. Thus it is present in the blood, organs, nervous tissue, and in most body fluids of almost all the animal orders, and is, in fact, now considered an essential constituent of living protoplasm. The following table will give an idea of the quantities present in some typical animal and vegetable sources :—

ANIMAL.

	% Sterol.
Hen's egg	.25 grs each
Milk, Cow	.015
,, Human	.019
Butter	.24
Blood	.15
Liver	.30
Cod-Liver Oil	.42
Bile	.54
Brain	1.9
Suprarenal Gland	4.7

PLANT.

	% Sterol.
Wheat Grain	.03
Grass	.05
Rice	.03
Olive Oil	.21
Linseed Oil	.42

It is a remarkable fact that, with a few noteworthy exceptions, the sterol obtained from animal sources is identical with the substance first isolated in gallstones, because in the plant world the greatest variety prevails. A multitude of sterols, which, however, differ little save in their physical constants, has been catalogued from the various plant sources. A representative list of these is given below :—

The vegetable sterols frequently occur as glucosides, and this fact, together with the difficulty in obtaining sufficient quantities that can be carefully purified, may help to account for the large number of individual sterols described, of which the above are merely representative. Turning to the attempts that have been made to unravel the constitution of cholesterol, we may summarise the present position as follows :

(i) Empirical formula $C_{27}H_{46}O$ was arrived at by Chevreul, and is still generally accepted, though there is some evidence that hydrogen may be H_{48}.

(ii) It is a secondary alcohol. Contains one unsaturated linkage. Can be reduced to $C_{27}H_{48}$.

(iii) From a study of the products obtained by drastic oxidation, especially with nitric acid, Windaus was able to demonstrate the existence of an iso-octyl side-chain, so that we can write provisionally

$$(C_{18}H_{27}O)CH.\underset{\displaystyle CH_2}{CH}(CH_2)_3CH\begin{cases}CH_3\\CH_3\end{cases}$$

As will be realised, such a substance is capable of exhibiting numerous stereoisomers, and these are actually met with, and have, in fact, given rise to considerable confusion especially because of their marked power of crystallising together. Thus the products obtained by gentle reduction are markedly different according to whether the process is carried out biologically or by means of such agents as H and platinum black, H and nickel, etc.

Isolation and Estimation.—The sterols usually occur associated with fats, from which they can be freed by means of

	Formula	M.P.	α	Source.
Animal.				
Cholesterol	$C_{27}H_{46}O$	148°C	−36	Very widespread.
B. Cholestanol	$C_{27}H_{48}O$	141		Fæces of some animals
Coprosterol	$C_{27}H_{48}O$	97	+24	
Isocholesterol	$C_{26}H_{46}O$?	140	+60	Wool fat.
Spongosterol	$C_{27}H_{48}O$	124	−19	Sponge
Vegetable.				
Chortosterol	$C_{27}H_{54}O$	78.5-5-79.5		Grass.
Carotol		132 7		Beet, Carrot.
Sitosterol	$C_{27}H_{24}O$	137	−34	Wheat germ, Calabar bean.
Stigmasterol	$C_{30}H_{48}O$	170	−45	Calabar bean.
Erosterol		165		Certain fungi.
Olestranol		165		Oleander.
Arnidiol		250		Arnica.
Cucurbitol	$C_{24}H_{40}O_4$	260		Watermelon seed.
Alcornol	$C_{22}H_{34}O$?	205		Jaborandi bark.

saponification. If sufficient material is available, the unsaponifiable matter can then be crystallised from alcohol, and the sterol thus removed from the accompanying substances, some of which, however, are also of a sterol-like nature—the so-called sterol oils. The methods of estimation are still in a somewhat unsatisfactory state, and may be broadly classified as (a) colourimetric, (b) gravimetric. In the former group advantage is taken of the green colour given by most sterols when in chloroform solution if mixed with acetic anhydride and sulphuric acid. Though not a specific reaction, and though open to other objections, this method is of considerable service, especially when dealing with small quantities of pure sterol.

Several gravimetric methods are available, but the standard process is that described by Windaus (1909). This consists in preparing and weighing the highly insoluble compound which most sterols form with digitonin, a saponin obtained from fox-glove leaves.

Sterol Oils.—Reference was made to the bodies that often accompany the true sterols in crude unsaponifiable matter. These are yellowish oils, or glosses, that have practically the sterol percentage composition, and also resemble them in other respects. They are difficult to characterise, and in spite of the considerable amount of work that has been carried out on them, little is known about their true nature. They might, for instance, be regarded as polysterols, though some evidence is directly opposed to this view.

Bile Acids.—The work of the last few years has revealed the close chemical relationship of another group of much more importance, namely, the bile acids, of which cholic acid, $C_{24}H_{40}O_5$, may be taken as representative. There is a considerable variety in the bile acids obtained from various animals, and the subject requires much more work, but there is good evidence for the view that they possess the same carbon skeleton as cholesterol, but with three carbon atoms less in the side-chain. In fact, Windaus has carried out a virtual conversion of cholesterol into cholic acid. This relationship has, of couse, considerable interest from the physiological standpoint.

In concluding this very brief summary of a most interesting group of substances, we would refer to the excellent summary given in the new edition of Allen's "Organic Analysis," or the more exhaustive treatment of "Biochem. Handlexicon," vols. 3 and 10 (1923).

It must be obvious from the foregoing how much remains for future investigation, while the material is readily available, or could easily be accumulated, *e.g.*, from the small quantities of unsaponifiable matter so frequently thrown away. The recent experiments showing the growth-promoting properties of irradiated cholesterol, suggesting a synthesis of vitamine A, at least shows that we cannot afford to disregard them.

—*Journal of the South African Chemical Institute.*

PROCEEDINGS AND NOTICES OF SOCIETIES.

FARADAY SOCIETY.

The Influence of Lyophilic Colloids on the Precipitation of Insoluble Salts, Gelatine and Silver Chromate. Part I. By THOMAS ROBERT BOLAM AND MARY RUSSELL MACKENZIE.

INTRODUCTION.

Williams and MacKenzie have determined the minimum concentrations of gelatine necessary to prevent precipitation of silver chromate by the interaction of equivalent solutions of silver nitrate and potassium chromate. It was assumed that precipitation had not taken place if no red substance was discernible. Although mixtures containing sufficient gelatine were clear yellow, considerable quantities of silver chromate were present, *e.g.*, 530×10^{-5} NAg_2CrO_4 in 4.4 per cent. gelatine. Under the conditions of these experiments clear red gels were never obtained. It was also found that the silver chromate in the yellow gels diffused like a crystalloid. Sen and Dhar, however, state that they failed to reproduce some of the results of the diffusion experiments of Williams and Mackenzie. The latter suggested that calcium was present in sufficient quantity to be a possible factor in causing the apparently increased solubility of silver chromate. Recent work has emphasised the fact that the properties of gelatine are greatly influenced by acidity. In particular Loeb has shown that the behaviour of gelatine towards salts in solution depends upon the hydrogen ion concentration. This factor was not considered by either Williams and Mackenzie or Sen and Dhar. The objects of the present investigation were to ascertain the effect of remov-

ing the calcium impurity, to study the influence of acidity, and to repeat the diffusion experiments.

THE EFFECT OF REMOVING CALCIUM.

The remainder of the gelatine used by Williams and MacKenzie was employed in these experiments and the calcium was removed by means of acetic acid. It was assumed that the whole of the ash was calcium oxide and slightly more than its equivalent of acetic acid was added to a weighed quantity of gelatine. After standing for forty-eight hours the liquid was decanted and the gelatine washed, with frequent change of distilled water, for three to five days. At the end of this time the washings gave no precipitate with ammonium oxalate. Throughout these operations the gelatine was kept at the temperature of tap water. In order to diminish bacterial action the wash water was boiled, and a piece of thymol suspended from the corks of flasks containing gelatine. Owing to the tendency of gelatine to grow moulds, sufficient for the whole of the work could not be washed at once, but the treatment was the same for each sample. The gelatine was dispersed and the concentration of the solution determined by drying a known volume to constant weight at 105° C. Ignition left only a trace of ash which did not colour the flame.

SUMMARY.

1. The power of gelatine to prevent precipitation of silver chromate is not dependent on the presence of calcium.

2. The efficiency of the gelatine increases with increasing acidity.

3. The silver chromate present in gels containing sufficient gelatine to prevent its precipitation diffuses like a crystalloid.

5. There is no evidence of the presence of silver chromate in the colloidal state.

PART II.

In Part I. evidence was presented which tended to show that a considerable portion of the silver chromate in a silver chromate-gelatine mixture containing sufficient gelatine to prevent precipitation behaved more as a crystalloid than as a colloid. It was suggested that silver and chromate were possibly present as simple ions, in greater amount than in saturated aqueous solutions. The silver ion concentration has, therefore, been investigated by determining the potential developed when silver was immersed in the silver chromate-gelatine mixtures. The conductivities of the latter have also been measured to determine to what extent the silver chromate was present as electrolyte.

E.M.F. DETERMINATIONS.

The compensation method was employed, two standard resistance boxes being used instead of a metre bridge. The total resistance in the two boxes together was kept at 11,110 ohms and the ratio between them varied. The null point instrument was an Ayrton Mather mirror galvanometer by Paul and the standard a cadmium cell by W. G. Pye. A.R. silver nitrate, potassium chromate and potassium nitrate were used, and, with one exception, gelatine B. All solutions were made up with N.P.L. calibrated apparatus and all experiments carried out in a thermostat at 25° C.

The potential of cells of the type

$$Ag \quad \begin{matrix} AgNO_3 \\ N/10 \end{matrix} \quad \begin{matrix} NH_4NO_3 \\ 10\ N \end{matrix} \quad X \quad Ag$$

has been determined. X denotes solutions containing silver chromate with or without other electrolytes and gelatine. In some of the earlier experiments a standard calomel electrode was used, but as the results obtained directly agreed with these, it was abandoned as an unnecessary complication. 10 N ammonium nitrate was chosen as connecting liquid since it was assumed that by so doing liquid-liquid junction potentials were eliminated.

SUMMARY.

1. The silver ion concentration in mixtures of silver nitrate, potassium chromate and gelatine have been measured electrometrically.

2. Its value may be *much* greater than in saturated aqueous solution of silver chromate. There is an optimum concentration of gelatine for each concentration of silver chromate. More or less gelatine leads to decrease of silver ion.

3. In mixtures where precipitation occurs the silver ion concentration falls off at a rate which may be very slow and which depends upon the relative concentrations.

4. The conductivities of the mixtures have been determined and confirm the e.m.f. results.

5. It has been found that gelatine reduces the conductivity of aqueous solutions of silver nitrate, potassinm chromate, and potassium nitrate, the effect being much greater in the first two than in the last.

6. The conclusion is that when equivalent solutions of silver nitrate and potassium chromate are mixed in the presence of gelatine to give a clear yellow system, the gelatine removes a portion of the salts from solution and maintains the remaining silver chromate in a state of supersaturation.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS.

An ordinary meeting of the Society was held at the Chemical Society's Rooms, Burlington House, on Wednesday, October 6, 1926, Mr. E. Richards Bolton, President, being in the chair.

Certificates were read for the first time in favour of Miss Gertrude Garland Andrew, B.Sc.; Messrs. Charles Edward Barrs, F.I.C., Thomas Hedley Barry; Gordon Watson Douglas, B.Sc.; Clarence Victor Ferriss, B.Sc., A.I.C.; and Reginald Charles Pakes, B.Sc.

A certificate was read for the second time in favour of Mr. Stafford Aston, F.I.C.

The following were elected Members of the Society:—Messrs. Francis Harrold Banfield, M.Sc., Ph.D., A.I.C.; and Albert Loster Williams, A.I.C.

The following papers were read and discussed:—

On the Presence of Compounds of Arsenic in Marine Crustaceans and Shell Fish. By A. CHASTON CHAPMAN, F.I.C., F.R.S.

Marine crusteans and shell fish have been found to contain from 10 to 174 parts of arsenic (as As_2O_3) per million of the wet edible portions. Native oysters contained from 5 to 10 parts, and Portuguese oysters from 33 to 70 parts per million. In fresh water fish, shell fish, and crustaceans, the amounts of arsenic ranged from only about 0.4 to 1.5 parts per million. The arsenic in the marine animals is therefore derived from the sea water, and the author gives the amounts of arsenic in sea water from various localities. Potted and canned crustacea and shell fish contained from 0.5 to 85 parts of arsenic per million. The arsenic in the urine of two experimental subjects was raised from the normal figure of about 1/200th grain per gallon to 1/2 grain in one case, and 1/3 grain in the other, after a meal of lobster. The physiological and toxicological bearings of the investigation are discussed.

On the Presence of Lead and other Metallic Impurities in Marine Crustaceans and Shell Fish. By A. CHASTON CHAPMAN, F.I.C., AND H. LINDEN.

The following amounts of copper (parts per million of the dried edible portion) were found:—Lobster, 167; crab, 130; and whelks, 115. The amounts of lead ranged from 5 (whelk) to 25.6 (lobster). Native oysters contained from 12 to 400 parts and Portuguese oysters 10 to 307 parts of lead per million. Like the arsenic, these metallic impurities are probably derived from the sea water.

The Examination of Fish for Formaldehyde. By A. R. TANKARD, F.I.C., AND D. J. T. BAGNALL, F.I.C.

Various kinds of fish gave a positive reaction in Schryvor's phenylhydrazine test, indicating the presence of 1 to 2 parts per million of formaldehyde. Since, however, trimethylamine (a common constituent of fish) can be readily oxidised to formaldehyde, a positive reaction does not necessarily indicate the presence of added formaldehyde. The reaction tends to be less marked when putrefaction of the fish has set in.

The Potentiometric Titration of Tin with Potassium Bromate. By KARL SANDVED.

The best results (error 0.5 per cent.) were obtained by oxidation of the stannous tin with antimony chloride or ferric chloride, and potentiometric titration of the duction compound with potassium bromate reduction compound with potassium bromate. A method of determining tin in the presence of antimony has been devised, and the potentiometric titration of ferrous iron has been closely studied.

The Determination of Nicotine in Tobacco. By R. R. T. YOUNG, M.Sc.

Keller's, Kissling's, and other methods have been critically examined. Accurate results are obtained by extracting the tobacco with a mixture of petroleum spirit, ether and aqueous potash, shaking the ethereal extract with dilute (1 : 1) alcohol containing cochineal, adding excess of hydrochloric acid to the separated aqueous layer, and titrating with standard sodium hydroxide. Ammonia is best determined by distillation after precipitation of the nicotine with iodine, but little ammonia, if any was present in the tobacco examined.

ELECTRIC PRECIPITATION APPLIED TO GAS STREAMS.

By H. R. HANLEY.

(*Missouri School of Mines.*)

January, 1926.

(*Continued from Last Week.*)

There is evidence, then from investigations and deductions which leads to the view that at least part of the mass of an atom of any element is of electrical origin, and that the atoms of different elements differ only in the number and grouping of the ultimate units of negative charge called electrons.

When an electron is added to a particle or molecule of any substance in the neutral state it is then said to be a negative ion.

A *negative ion* or carrier of a negative charge is formed when a *neutral molecule* of a material substance, such as a particle or dust, vapour, or smoke, has received from any source whatever one or more electrons in excess of the number contained in its neutral state. The magnitude of the charge depends upon the number of electrons which have been added to the neutral molecule or aggregate. Similarly a positive ion is formed when a neutral molecule or aggregate has had one or more electrons removed from it.

An illustration of this principle is the countless number of minute water particles floating in the air, clouds, etc. This floating matter may exist more or less in the form of aggregates, which may have been formed by the condensation of water vapour on the dust or particles as nuclei, or during their fall due to gravitation they may unite to form small drops. These drops are more or less charged with positive electricity probably due to evaporation taking place at the surface of the earth upon bodies of water.

When condensation centres begin to form, the aggregates have a resultant charge equal to that of the individual particles composing it.

Ionisation.

By ionisation is meant that process by means of which the atoms and molecules of matter are split into positively and negatively charged particles, or positively charged particles (Ions) and electrons. The principal ionising agents are the Roentgen and Becquerel rays, cathode rays, electric fields, high temperatures, ultra violet light and chemical action.

High Temperature.

When the temperature of a body becomes sufficiently high the velocity of some of the electrons is sufficiently great to carry them into the surrounding medium. There are also particles or molecules of the body itself sent off into the adjacent surroundings. These particles, associated with negative and positive charges, constitute the streams of negative and positive ions.

The thermal ionisation from the fuel and hot surfaces in a furnace or fire box may aid in giving an initial charge to the particles with which the electrical precipitation of smoke is concerned.

Water Spray.

Investigation on the ionisation action of fine jets of water in the form of sprays, shows that both negative and positive ions are produced, the negative ions being slightly more numerous than the positive ones. It may be that the ionisation produced by the water jets has some effect upon the removal of suspended matter in air washers. The electrons, however, seem to attach themselves with difficulty to water drops, even though they be of very small sizes. These facts may explain positive electrification of atmospheric clouds as due to evaporation of water.

Theory of Electrical Precipitation.

In general, solid and liquid particles may be considered as susceptible to the action of either or both electric or magnetic fields.

Material particles may be classified in two groups, conducting and non-conducting. When conducting particles are brought into an electric field, each side of the particle has an accumulation of positive and negative electricity, and it is customary to say that the eleeric field has polarised he particles. Independent of this polarisa tion action there may be present positive and negative ions and electrons in the field. These ions and electrons as a result of collisions among themselves and with polarised particles, will tend to combine with polarised particles and form what are called large ions or aggregates.

The velocity of large ions is very low and consideration is given to this fact in the design of a precipitation plant to treat such a gas stream.

The electrical precipitation of solids from gas streams is much more widely applied to those ladened with non-conducting particles.

Discharges in Cottrell Process.

Before discussing the research work and experimental operations on the Cottrell process, some mention should be made of the reasons for the adoption of certain apparatus and the characteristics of it.

There are two types of precipitation, the plate and wire type, and the pipe and wire type. The wire constitutes one electrode and the plate or pipe the other, depending upon whether the plate system or the pipe system is used. The question now arises which electrode should be positive and which negative It has been determined that high efficiency of the precipitator is

largely dependent upon the maintenance of a large difference in potential between the electrodes through which space the dust or fume-laden gas stream passes, and a uniform control of a low uni-directional current. In order to maintain these electrical characteristics, knowledge as to the behaviour of each electrode when used as a positive or negative pole becomes necessary.

Humphreys in 1900 discovered that when two metallic conductors connected with a source of static electricity and oppositely charged to the point of arcing, were separated until the arcing ceased, the arcing was resumed when a thin glass rod was brought close to the positive electrode facing the negative pole, but no arcing occurred when the glass rod was brought close to the negative electrode. Another statement of this phenomena is that the point negative requires a greater potential to cause arcing than does the point positive. Mechanical rectifiers delivering an uni-directional current at high potential utilize the principle of this phenomenon. Similarly this principle is utilised in the precipitator itself by making the wire negative and the large surface of pipe positive. This method makes possible the use of a much higher potential difference between the two electrodes, than would be the case if the conditions were reversed. Inasmuch as a high potential difference is necessary, as previously stated, the wire is always made negative and the pipe positive, the latter being connected to the ground.

This arc-over voltage of an electrode is altered when the distance between the electrodes is considerably reduced. At sparking distances less than 2.3 mm. this sparking voltage is less for the point negative than for the point positive, but for distances greater than 2.3 mm. the sparking voltage is greater for the point negative than for the point positive. In all Cottrell work the distance is much greater than 2.3 mm., and, of course, the difficult arcing characteristics of the point negative is made use of. The wire being negative, there is a high concentration of electrons driven into the field toward the collecting electrode. These are sufficient in quantity to cause a surge, or what is spoken of as "electric wind," toward the collecting electrode. The positive ions from the collecting electrode come toward the negative wire at a very attenuated concentration compared with the electrons from the negative wire. In this consideration the view is held that the various ions have a positive nucleus with a number of electrons around it; that the positive ions have a great tendency to receive electrons, thus becoming neutral or negatively charged particles, and in the field of high electron concentration the number of positive particles will therefore cease to exist as positive particles. The negative particles will not be affected in the electron stream in the same way as only a relative few of them will change sign, and this is due to at least more than one electron being knocked out from the particle; however, with so many negative electrons around, a great number of these particles will get back to their previous state.

These electrons driven at high velocity and concentration into the stream collide with the dust and fume thus imparting negative charges to these particles. These negative charged particles, with the electrons, move through the field toward the positive collecting electrode (pipe) according to the principles of electrostatics. When the collecting electrode is reached these charges of negative electricity are given up to the positive collecting electrode and deposit their freight (dust particles) on the walls of the pipe (Collecting Electrode). There is some tendency, however, for some of the dust to be precipitated on the active or negative wire due to the strong electric field there. It is found that this lesser effect of the lesser concentrated positive ions emanating from the relative large surface of the positive electrode gives rise to a very limited deposition at the negative wire. Furthermore, the great physical influence of the large surface presented by the positive electrode, affording a lodging place for the particles of dust, must also be taken in account. Precipitation by mere polarisation is not found to be practicable, and, in fact, good precipitation does not occur at all until there is obtained a maximum corona current between the electrodes, and it becomes better as sparking potential is approached. There are certain deposits cause a lowering of the potential difference between the electrodes, with a rise in current while in other deposits the opposite condition is developed. The subject of great variations in voltage in the Cottrell process, and particularly during the failure to precipitate the solid in the gas stream due to disruptive discharge, and a similar effect due to the corona current falling to zero with a corresponding abnormally high

voltage, is closely related to dielectric characteristics of the deposited dust. When such abnormalities occur the cause is usually due to the characteristics of a *compound* dielectric, such as metallic oxides plus air. There is also a notable difference in characteristics among the oxides themselves.

FORTHCOMING EVENTS.

SOCIETY OF GLASS TECHNOLOGY.

The next meeting will be held in the Lecture Room of the Coal, Gas and Fuel Industry Department, The University, Leeds, at 2.30 p.m., on Wednesday, October 20. A general discussion on "Annealing and Lehrs," will take place.

At the Sheffield Meeting on November 17, 1926, the Society of Glass Technology will celebrate its Tenth Anniversary. Members are requested to make a special note of this date.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

Savoy Place, Victoria Embankment, London.

Thursday, October 21, at 6 p.m.—Inaugural Address by the President, Mr. W. H. Eccles, D.Sc., F.R.S. (Light refreshments at 5.30 p.m.)

Correspondence

CHLORINE IN RAIN AND SNOW PRECIPITATIONS.

To the Editor of the CHEMICAL NEWS.

Sir,

In your issue of July 13, 1923, John H. Woehlk and myself gave a summary of the results of our analyses of the precipitations at Mount Vernon ,Iowa, from October 1, 1922 to June 1, 1923. We there stated that the chlorine content varied from 3.54 parts to 28.1 parts per million.

Recently our attention has been called by Dr. W. D. Collins, of the United States eological Survey, Chemist in charge of the Quality of Water Division, Washington, that 28.1 parts per million seems high for this section.

Mr. Woehlk and I reviewed our work, and found for the three highest values we used a hundredth normal solution of silver nitrate and by mistake, called it a tenth normal solution. Therefore, these three results are ten times too large.

The revised figures are about what one would expect for the chlorine content of the rains and snows of this section and correspond to results obtained in other years.

I am,

Yours, etc.,

NICHOLAS KNIGHT.

Cornell College,
Mount Vernon, Iowa, U.S.A.
September 25, 1926.

NOTICES OF BOOKS.

Structure et Activité Chimiques. Rapports et Discussions du deuxième Conseil de Chimie. Tenu à Bruxelles du au 24 Avril 1925. Sous les Auspices de L'Institute International de Chimie Solvay. Pp. XIV + 672. Paris: Gauthier Villars. 1926. Price 80 francs (+ 20% increase).

This volume contains the papers presented at the second conference held under the auspices of the Solvay International Institute at Brussels. The papers deal with subjects of considerable importance and were read by very distinguished authorities. The four sections are headed: The Spreading of Liquids on Water; Crystallised Structure and X-rays; Chemical Activity; and the Reactivity of Molecules. Sir W. B. Hardy, Prof. Bragg, Prof. Ducluax, Prof. Lowry, Prof. Swarts, Drs. Tiffeneau, and Orékhoff, and Prof. Perrin ,among others, have contributed to this monumental work.

Inorganic Quantitative Chemical Analysis. By WILFRED SCOTT, Sc.D. (Professor of Chemistry, University of Southern California). VI + 178 pp., with Table of Atomic Weights, and on Page 3 of Cover, Solubility Table-grams of Anhydrous Salts per 100 c.c. of Water at 18° C. Price $2.50, post paid. The Chemical Publishing Coy., Easton, Pa., U.S.A.

Both the contents, and in the arrangement of the matter, this book is likely to command a good share of approval and support. First, the gravimetric methods of analysis are set out in clear language, then follow on the volumetric methods. The author follows standard methods, and references are given for the various authorities. College students, for whom the work was mainly written, will find the book helpful, while it is deserving of a place is any scientific library.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

23,598.—Agopion, L. A.—Production of concentrated vitamine preparations. September 24th.

23,162.—British Dyestuffs Corporation, Ltd.—Manufacture of derivatives of 2 : 3 hydroxynaphthoic arylides. September 20th.

23,129.—Geipert, R.—Distilling small samples of coal. September 22nd.

23,129.—Hatfield, H. S.—Means for effect-chemical analysis of liquids. September 20th.

23,703.—Imray, O. Y. Manufacture of isatin derivatives. September 25th.

23,274.—Imray, O. Y.—Manufacture of anthraquinone derivatives. September 21st.

Specifications Published.

258,340.—Cicali, G.—Apparatus for the synthesis of ammonia.

236,538.—Abbott Laboratories.—Process for producing di-acet-oxy-mercuri-4-nitro-ortho-cresol and compounds thereof.

258,462.—Gammay, H.—Process for the production of camphor from isoborneol.

258,475.—Gammay, H.—Process for the production of isoborneol from a mixture of camphene and associated oils.

Printed Copies of the full Published Specification may be obtained from the Patent Office, 25 ,Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

Abstract Published.

256,068.—Chlorhydroxyanthraquinone. —H. Dodd, W. C. Sprent, and United Alkali Co., Ltd., Cunard Buildings, Liverpool.

Chlorhydroxyanthraquinone free from hydroxyanthraquinone is produced by condensation of phthalic anhydride and *o*- or *p*-chlorphenol in sulphuric acid without the use of either boric acid or aluminium chloride, the temperature not appreciably exceeding 200° C. Specification 245,784 is referred to.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

GASODA.

472,002.—Remedies for acid stomach, heartburn, indigestion, dyspepsia, and nausea.—Hauce Bros., and White Inc. Corner of Marshall and Callowhill Streets, Philadelphia, Pennsylvania, U.S.A. September 29th.

BRONTIK.

472,517.—Chemical snbstances prepared for use in medicine and pharmacy.—Arthur John Stanley, trading as John Stanley, 10, Clarendon Road, Harrow, Middlesex. September 29th.

472,373.—Illustration of Poppy and the words RED POPPY CORN CAPS.—Preparations for removing corns.—Fassett & Johnson, Ltd., 86, Clerkenwell Road, London, E.C.1. September 29th.

UNIVERSITY OF MANCHESTER.
CHEMISTRY COURSES.

A Prospectus containing full particulars of the Lectures and Laboratory Courses qualifying for Degrees in Chemistry will be forwarded on application to the Registrar.

The Session commences on OCTOBER 7TH. Applications for admission to the Research Laboratories should be made to the Director of the Chemical Laboratories.

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THE STRUCTURE OF ALUMINIUM.

By HAWKSWORTH COLLINS, B.A. (Camb.).

The demonstration of the constitution and structure of an atom of aluminium was commenced on October 11, 1907, in the *Chemical News*, XCVI., 176, and was continued in the following :— 1913, CVII., 99; 1913, CVIII., 235; 1914, CIX., 26; 1919, CXIX, 295; *etc.*

This structure will now be proved to be correct quite independently by means of the laws of relative volume and heat of formation; *i.e.*, by means of two series of facts, S.G., and H.F., which are absolutely independent of one another and of the facts which were originally employed to discover the constitution of Al.

TABLE I.
THE RELATIVE VOLUMES OF ALUMINIUM.

(1)	Al(27)	=	Na(23)	+	H	+	H,
(2)	9.05	=	6.54	+	0.97	+	1.54
(3)	12.05	=	9.54	+	0.97	+	1.54
(4)	23.7	=	23.7	+	0	+	0
(5)	29.46	=	23.7	+	5.76	+	0
(6)	10.05						

All these volumes and part-volumes, except 29.46 and 10.05, have been demonstrated in previous papers, especially in those on sodium, magnesium, silicon, phosphorus, and sulphur.

In Table II. each theoretical S.G. is obtained, as in all preceding papers, by dividing the molecular weight (sum of whole numbers) by the sum of the relative volumes. The only element whose atomic weight is not taken as a whole number is chlorine, for reasons given in *Chemical News*, 1924, CXXIX, 268.

TABLE II.
EXPERIMENTAL DATA ILLUSTRATING TABLE I.

	Relative Volume.	Theor. S.G. at 15°	Obs. S.G.	
(7)	Al_2O_3 2(9.05) + 3(2.51)	3.98	3.98	14° Grandeau
(8)	AlO_3H_3 9.05 + 3(2.51) + 3(5.76)	2.30	2.3	Chem. Kal.
(9)	$Al_2O_3.2H_2O$ 2(9.05) + 3(2.51) + 2(14.03)	2.570	2.55	Dana
(10)	$AlMg_3O_9H_9.3H_2O$ 9.05 + 3(7.51) + 9(2.51) + 9(5.76) + 3(14.03)	2.066	2.04 - 2.09	Dana
(11)	Al_2SiO_5 2(9.05) + 13.02 + 5(2.51)	3.71	3.678	Jacobson
(12)	Si 13.02	2.15	2.004 - 2.194	Winkler
(13)	$AlNaSi_2O_8$ 9.05 + 11.85 + 2(13.02) + 6(2.51)	3.26	3.26	Damour
(14)	$Al_2SiO_4F_2$ 2(9.05) + 13.02 + 4(2.51) + 2(5.42)	3.55	3.52 - 3.56	Kokscharow
(15)	$Na_5Al_3F_{14}$ 5(11.85) + 3(9.05) + 14(5.42)	2.847	2.824 - 2.898	Rammelsberg

(16)	$AlCu_5$ 9.05 + 5(7.02)	7.746	7.727	Hirzel
(17)	$AlCu_4$ 9.05 + 4(7.02)	7.514	7.534	Hirzel
(18)	Cu 7.02	8.97	8.96	Berzelius

(In the above all the oxygen atoms have their lowest possible volume of 2.51. In the following there is one oxygen atom of volume 7.53 for each silicon element present. The latter is the most usual state of affairs.)

(19)	$Al_2Si_2O_9H_4$ 2(9.05) + 2(13.02) + 2(7.53) + 7(2.51) + 4(5.76)	2.585	2.4 – 2.63	Dana
(20)	$Al_3NaH_2Si_3O_{12}$ 3(9.05) + 11.85 + 2(5.76) + 3(13.02 + 7.53) + 9(2.51)	2.834	2.895 2.779	Oellacher Schafhautl
(21)	$Al_2Ca_2H_2Si_3O_{12}$ 2(9.05) + 2(14.54) + 2(5.76) + 3(13.02 + 7.53) + 9(2.51)	2.88	2.845 – 2.897	4° Streng
(22)	$Al_3KH_2Si_3O_{12}$ 3(9.05) + 18.05 + 2(5.76) + 3(13.02 + 7.53) + 9(2.51)	2.82	2.830 2.796	Tschermak Grailich
(23)	$Al_2SiO_5.6H_2O$ 2(9.05) + 13.02 + 7.53 + 4(2.51) + 6(14.03)	2.03	2.02	Schnadel
(24)	$TlAl(SO_4)_2.2H_2O$ 17.3 + 9.05 + 2(35.61) + 2(14.03)	3.65	3.645	17° Pettersson
(25)	$RbAl(SO_4)_2$ 26.57 + 12.05 + 2(35.61)	2.77	2.79	15° Pettersson
(26)	$KAl(SO_4)_2.12H_2O$ 22.29 + 12.05 + 2(35.61) + 12(14.03)	1.73	1.726 1.753	Playfair & J. 13°/4 Interntl.
(27)	$KAlSiO_4$ 22.29 + 12.05 + 13.02 + 7.53 + 3(2.51)	2.531	2.493 2.602	Scacchi Miersch
(28)	$AlKSi_3O_8$ 12.05 + 22.29 + 3(13.02) + 3(7.53) + 5(2.51)	2.561	2.57 2.55	Breithaupt 16° Hautefeuille
(29)	$Al_5BaNa_3Si_{11}O_{32}$ 5(12.05) + 24.58 + 3(11.85) + 11(13.02 + 7.53) + 21(2.51)	2.906	2.906	Levy
(29A)	$Al_4O_6H_6PO_4.6H_2O$ 3(12.05) + 6(2.51) + 6(5.76) + 29.62 + 6(14.03)	1.934	1.939	Forbes
(29B)	Al_4C_3 3(9.05) + 12.05 + 2(8) + 5.69	2.365	2.36	Interntl.
(30)	$Al_8Na_4Si_9O_{24}Cl$ 8(12.05) + 4(11.85) + 9(13.02 + 7.53) + 15(2.51) + 15.085	2.629	2.626	19° Rath
(31)	$Al_5CaNa_3Si_{11}O_{32}$ 5(12.05) + 14.54 + 3(11.85) + 11(13.02 + 7.53) + 21(2.51)	2.675	2.66 – 2.68	Kerndt
(32)	Al_2O_3 (sapphire) 12.05 + 9.05 + 3(2.51)	3.562	3.562	Muschenbroek
(33)	$AlCl_3 + 3C_6H_6$ 12.05 + 3(15.085) + 3(89.7)	1.126	1.14 1.12	0° Gustavson 20° Gustavson
(34)	Benzene C_6H_6 89.7	0.87	0.8773 0.85	20° Naumann 15°.5 Faraday
(35)	$2AlCl_3 + 3C_{10}H_{14}$ 2(12.05) + 6(15.085) + 3(157.65)	1.139	1.139 1.127	0° Gustavson 18° Gustavson
(36)	Cymene $C_{10}H_{14}$ 157.65	0.85	0.857	16° Noad
(37)	$AlBr_3 + 3C_7H_8$ 12.05 + 3(23.09) + 3(106.12)	1.357	1.35	20° Gustavson
(38)	Toluene C_7H_8 106.12	0.866	0.866	20° Post

(39)	$2AlBr_3$ + $3C_{10}H_{14}$ 2(12.05) + 6(28.09) + 3(157.65)	1.473	1.477	16° Gustavson
(40)	$AlBr_3$ 23.7 + 3(27)	2.55	2.54	Deville
(41)	Na 23.7	0.97	0.97	Troost
(42)	$Al_2I_6.12H_2O$ 2(29.46) + 6(27.75) 12(14.03)	2.62	2,63	Chem. Kal.
(43)	$Al_2Li_2Si_5O_{14}$ 29.46 + 12.05 + 2(6.21) + 5(13.02 + 7.53) + 9(2.51)	2.41	2.40	12° Hautefeuille
(44)	$Al_2CaH_{10}Si_6O_{21}$ 29.46 + 12.05 + 14.54 + 10(5.76) + 6(13.02 + 7.53) + 15(2.51)	2.2	2.195	Thomson
(45)	$NaAl(SO_4)_2.12H_2O$ 11.85 + 29.46 + 2(30.59) + 12(14.03)	1.69	1.694	18° Pettersson
(46)	$AmAl(SO_4)_2.12H_2O$ 23.87 + 29.46 + 2(30.59) + 12(14.03)	1.602	1.602	Breithaupt
(47)	$RbAl(SO_4)_2.12H_2O$ 22.29 + 29.46 + 2(30.59) + 12(14.03)	1.85	1.852	Soret
(48)	$Rb_2CuCl_4.2H_2O$ 2(22.29) + 9.54 + 4(15.085) + 2(14.03)	2.884	2.895	Wyrouboff
(49)	$TlAl(SO_4)_2.12H_2O$ 22.29 + 29.46 + 2(30.59) + 12(14.03)	2.27	2.257	Soret
			2.320	20° Spring
(50)	$Al_2Na_2H_4Si_3O_{12}$ 29.46 + 12.05 + 2(11.85) + 4(5.76) + 3(13.02 + 7.53) + 9(2.51)	2.203	2.207	11° Gmelin
(51)	Al 10.05	2.688	2.688	Barlow
(52)	Al_4Sn 4(10.05) + 16.02	4.02	4.025	Hirzel
(53)	Sn 16.02	7.37	7.373	Deville
(54)	Al_2Sn 2(10.05) + 16.02	4.76	4.744	Hirzel
(55)	$AlSn_2$ 10.05 + 2(16.02)	6.25	6.264	Hirzel
(56)	$AlSn_3$ 10.05 + 3(16.02)	6.56	6.536	Hirzel
(57)	Al_2Cu 2(10.05) + 7.02	4.314	4.355	Hirzel
(58)	$AlCu_6$ 10.05 + 6(7.02)	7.763	7.751	Hirzel
(59)	Al_2Cu_{13} 2(10.05) + 13(7.02)	7.84	7.884	Hirzel

TABLE III.

	Heat of Formation of Al.								Orig. Vol.		Rel. Vol. in combination 15° C		Change of Volume
(59A)	37746	=	120	×	11.65	×	27		23.7	=	12.05	+	11.65
(60)	47466	=	120	×	14.65	×	27		23.7	=	9.05	+	14.65
(61)	66128	=	120	×	20.14	×	27		29.46	=	9.05	+	20.41
(62)	56408	=	120	×	17.41	×	27		29.46	=	12.05	+	17.41
(63)	-9720	=	120	×	(-3)	×	27		9.05	=	12.05	-	3

TABLE IV.

EXP. [R]IMENTAL DATA ILLUSTRATING TABLE III.

	Heat of Formation.				
(64)	$Al_2.O_3$ 2(47466) + 3(96155)	= 383397	385800	C.N. 19/11/20
	(corresponds with No. 7.)			
(65)	$Al_2.Cl_6$. aq. 2(47466) + 6(63870)	= 478152	475650	
(66)	aq. $Al_2.Br_6$ 2(47466) + 6(52930)	= 412512	410040	414500
(67)	$Al_2.Si_2.O_7$ 2(47466) + 2(0) + 7(96155)	= 768017	767500	
	(corresponds with Nos. 11, 13 & 14)			
(68)	$Al_2.I_6$ 2(47466) + 6(7010)	= 136992	140780	

(69) aq. $Al_2.I_6$ 2(47466) + 6(37720) = 321252 318780
(70) $Al_2.F_6$ 2(47466) + 6(76820) = 555852 550440
(corresponds with No. 15)
(71) Al. O_3. H_3 56408 + 3(96155) −
3(15300) = 298973 301300
(corresponds with No. 29A)
(72) $Al_2.O_3$ 47466 + 56408 + 3(96155) = 392339 392600
(corresponds with No. 32.)
(73) $Al_2.O_3.3H_2O$ 2(56408) + 3(96155)
− 3(3205) = 391666 388920
(corresponds with No. 29, etc.)
(74) Ca. O 59568 + 71515 = 131083 131500
(corresponds with No. 165 in C.N. 1924, CXXIX., 95.)
(75) $Ca.O.Al_2.O_3$ 131083 + 392339 = 523422 524550 v. (74), (72).
(76) $Ca_2.O_2.Al_2.O_3$ 2(131083) + 392339 = 654505 658900
(76A) aq.$S.O_3$ 6217 + 2(32341) + 71515 = 142414 142410 T.
(76B) $Al_2.S_3.O_{12}$ 47466 + 37746 + 3(6217)
+ 6(96155) + 6(32341) = 874839 879700
(77) $Ca_3.O_3.Al_2.O_3$ 3(131083) + 392339 = 785588 789050
(78) $Ca_3.O_3.Al_2.O_3.Si_2.O_4$ 3(131083) +
392339 + 2(0) + 4(96155) = 1170208 1195690
(79) $Al_4.C_3$ 3(66128) + 56408 − 2(13855)
+ 4918 = 232000 232000
(corresponds with No. 29B.)
(80) $Al_2.Cl_6$ − 2(9720) + 6(56786) = 321276 321960
(corresponds with Nos. 33 and 35.)
(81) $Al_2.Br_6$ − 2(9720) + 6(45244) = 252024 243900 239440
(corresponds with Nos. 37 and 39.)
(82) H.Cl.aq. 24350 + 63870 = 39520 39315 Thomsen
(83) liq.$H_2.O$ − 2(24350) + 117460 = 68760 68360 Thomsen
69000 Berthelot

HEAT OF NEUTRALISATION.

When twice (71) and six times (82) produce (65) and thrice (83)

6(96155) becomes 6(117460)
6(−15300) becomes 6(−24350)
2(56408) becomes 2(47466)

(84) 6(117460) − 6(96155) − 6(24350) +
6(15300) + 2(47466) − 2(56408) = 55646 55920 T

HEAT OF SOLUTION OF METAL.

When six times (82) and Al_2 produce (65) and six atoms of H,

2(0) becomes 2(47466)
6(−24350) becomes 6(0)

(85) 2(47466) + 6(24350) = 241032 239760

HEAT OF SOLUTION.

When (80) produces (65),

−2(9720) becomes 2(47466)
6(56786) becomes 6(63870)

(86) 2(47466 + 9720) + 6(63870) −
56786) = 156876 153690 T

HEAT OF ADDITION.

When aq. $Al_2.3(O.SO_3)$ produces $Al_2(SO_4)_3$ aq., (H.F.aq. SO_3 is given in No 76A),

0 becomes 47466
0 becomes 37746
3(0) becomes 3(96155)
3(71515) becomes 3(96155)

(87) 47466 + 37746 + 6(96155) −
3(71515) = 447597 451890

Corresponds with Nos. 24 and 25, where 35.61 = 15.53 + 2(7.53 + 2.51)

In No. 79 the H.F. of the last atom of carbon is obtained as follows :— The S.G. of gas-carbon is 2.08 by Baudrimont and 1.885 by Mene. If 12 be divided by 1.934, the result is 6.205. 6.205 = 5.69 + 0.515, so that 0.515 is the change of volume. 4918 = 795 × 0.515 × 12.

The volume 9.05 is correct for 21 independent reasons, 12.05 also for 21 reasons, and 29.46 for 11. Many more could be given in each case ,if space permitted. 23.7 is correct for 4 independent reasons, and 10.05 for 8.

SUMMARY.

There are here four separate proofs that the structure of an atom of Al has been correctly found. The first proof consists in the facts (a) that 9.05 appears in 18 molecules in Table II.; (b) that 9.05 can be split up into parts which have previously been shown to be volumes of Na, H and H_3; (c) in conjunction with three of the other volumes it gives the correct values of H.F. (Table III.), as shown in 16 cases in Table IV.

The other three proofs are similar, starting respectively with the volumes 12.05, 23.7 and 29.46.

The volume 10.05 cannot be split up in accordance with the law of relative volume, almost certainly because it is in reality the average of three volumes, *viz.*, one-third of 2(9.05) + 12.05; *i.e.*, it is obtained from a crystallised mass, two-thirds of whose atoms are 9.05 and one-third 12.05 in volume.

It is probably found by experimentalists, as in the case of Mg in the *Chemical News*, 1925, CXXXI., 212, that this mass has to be heated before being dissolved by acids, so that the atoms are temporarily in a new state, represented either by the volume 23.7 or by that of 29.46, or both.

This paper consists of the arrangement of 90 experimental data (provided by men who are or were experts in their several domains) in such a manner as to demonstrate the truths which underlie them. There is no hypothesis anywhere in the paper, and if any one particular fact (with its corresponding deduction) is found in the future to be wrong, the others would not be affected in the slightest. The deductions are very definite discoveries, not hypotheses.

In addition to the proofs that the structure of Al has been found correctly, this paper accomplishes several other objects. It strengthens the following laws, A, B, C and D.

(A) The Law of the Formation of Non-Metals :— The non-metallic nature of an element is always due to a pair or pairs of electro-positive forces, each pair emanating from a portion of the element, of which the mas is 4, taking the mass of an atom of H as unity.

Na is the metallic portion of Al, and H + H_3 the non-metallic.

(B) The Law of Electro-Positive and -Negative Valences :— The valences which emanate from the metallic portions of non-metals are electro-negative; all other valences are electro-positive.

In the case of Al, when aluminates are formed, an electro-negative valence emanates from the portion Na and combines with a base, and the two electro-positive valences emanating from the two portions H + H_3 combine with the two electro-negative valences of an atom of oxygen.

(C) The Law of Relative Volume :— The relative volume of an atom is the sum of the relative volumes of its parts, any one or more of which may be zero.

This is illustrated in Table I. When the volume of a portion becomes zero, this portion has been drawn inside the remainder of the element, and may increase the density of the atom without altering the size of this remainder.

(D) The Law of Heat of Formation :— The heat of formation of an element is proportional to the product of the atomic weight and the change of volume; there being two distinct series, the sodium elements and the sub-sodium elements.

The paper also illustrates and therefore strengthens the following Rules and Discoveries—E, F. G, H, I and J.

(E) The Odd and Even Rule :— When an element has an odd number of valences, its atomic weight is odd, and when it has an even number of valences, its atomic weight is even.

In the case of Al 3 valences emanate from a mass of 27; both being odd numbers.

(F) The Cause of the Odd and Even Rule :— (i) The only elements of atomic weight less than 60 from each of which a single electro-positive force is known to emanate are K(39), Na(23), Li(7), H(3)

and H(1). (ii) The atomic weight of each element below 60 (*i.e.*, including nearly all the common ones) can be split up in a uniform manner into as many parts, 39, 23, 7, 3 and 1 as the element has valences. (iii) The sum of an odd number of odd numbers is odd; and the sum of an even number of odd numbers is even.

(N.B.—There can be no exception to a Law, but there may be a few exceptions to a eneral Rule. A Rule may at any moment be converted into a Lew by the discovery of the reason for every exception).

In the case of Al, the sum of the three odd numbers 23, 1 and 3 gives the odd number 27.

(G) In the simple elements H(1) forms the connecting link between the other portions, 39, 23, 7 and 3.

This is illustrated in the case of Al.

N.B.—If the atomic weight of Al had been any number but 27 between 16 and 30 inclusive, it could not have been split up in the manner shown.

(H) A mass of 23 (Na) takes a prominent part in the formation of all elements of greater atomic weight than itself.

(I) The discovery of the Relative Volume of each atom in every one of the thousands of different substances known. The fact that the discovery of the law (C) was made from these results proves that the relative volumes are correct.

(J) The Discovery of the Heat of Formation of each atom in a molecule. This is proved to be correct by the discovery of the Law (D). The paper also continues the demonstration of the following :—

(K) The conversion of the experital data of S.G. into exact instruments of research. (Table II.)

(L) The causes of Thomsen's experimental effects, not necessarily of his calculated effects.

(M) Water of crystallisation absorbs heat when formed from liquid water. No. 73, etc.

(N) It is impossible to *calculate* the H.F. of any substance (as Thomsen did) with any certainty of its being correct without the previous knowledge of the relative volume of each atom forming the substance.

The matter of this paper cannot be adequately appreciated without a study of the 24 similar papers with regard to other elements published by the *Chemical News* in the years 1924 and 1925.

The fact that four out of five relative volumes are intricately connected by the Law of H.F., as shown in Table III., makes it absolutely certain that there is no mistake, for the change of volume in each case has to be multiplied by such a large number as 3240 (= 120 × 27), which places them far out of the region of chance.

THE CATALYTIC OXIDATION OF HYDROCYANIC ACID II.

By Heima Sinozaki—Kogakushi, and Ryosaburo Mara—Kogakukahushi.

Summary.

1. In the first paper, the authors reported the catalytic oxidation of HCN into NO, by using platinum net as a catalyser in a manner similar to oxidation of ammonia into NO. They continued this study of the oxidation of HCN using the following catalysers—porcelain, silica, platinised asbestos, iron oxide, iron oxide mixed with bismuth oxide, cobalt oxide, cobalt oxide mixed with bismuth oxide, copper oxide, chromium oxide, nickel oxide, manganese oxide, and manganese dioxide mixed with copper oxide. It was found that each catalyser except porcelain and silica had a considerable catalytic power, and iron oxide mixed with bismuth oxide, cobalt oxide, cobalt oxide mixed with bismuth oxide, and manganese dioxide mixed with copper were almost equally effective as platinum net.

2. The phenomenon of activation was also observed with metal oxides as in the case of platinum net, and when activated, the yield of NO increased in many cases especially at relatively low reacting temperatures, though in some cases there was no remarkable change in the yield of NO.

3. The curves which expressed the relation between the HCN concentration and the yield of NO at 600° C. and 700° C. were found to be very similar in both of the cases of iron oxide mixed with bismuth oxide and platinum net.

The curves which expressed the relation between the yield of NO and the time of contact of the reacting gas with the catalyser were drawn and the properties of several catalysers were compared.

4. The authors' view, that HCNO should be instantaneously produced in the intermediate stage of oxidation of HCN into NO, was reinforced. With some oxide catalysers, less active than platinum, the solid intermediate oxidation products, all of

which were thought to be derived from HCNO, were obtained generally in some range of comparatively low reacting temperatures. At a little higher temperature than this, the production of these solid substances declined and the oxidation into NO began gradually to prevail; and at an adequately high temperature, the catalytic power of the catalyser becoming strong, NO, CO, or CO_2 were the stable oxidation products of HCN.

When the oxide catalyser was activated, this range of the reacting temperature to produce these solid substances was remarkably narrowed. With very active platinum net or platinum asbestos, this temperature range could not be observed any more, and only with the gas mixture of very high concentration of HCN—*i.e.*, of a deficient amount of oxygen—the solid intermediate oxidation products were obtained.

These solid products obtained with the oxide catalysers were Cyamelide $(HCNO)_n$, Cyanuric acid $H_3C_3N_3O_3$, ammonium cyanate, and urea.

WATER EXTRACT OF TOBACCO.—SOLUTION FOR SPRAYING TREES.

By Arthur Skibbe, M.A., B.Sc., A.I.C.

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(From "Farming in South Africa.")

The preparation of tobacco extracts containing an adequate quantity of nicotine for the control of aphis was undertaken by the Elsenberg School of Agriculture for the benefit of the fruit farmer.

For the extraction of the nicotine a number of solvents can be used, but as the object in these experiments was to prepare a suitable home-made tobacco extract, the writer restricted himself to the one most obvious and suitable solvent, namely, water.

In the preparation of a water tobacco extract the following factors would have to be considered :—(1) Quantity of tobacco used; (2) the amount of nicotine in the tobacco; (3) the condition in which the tobacco utilized (*e.g.* stalks or pods or leaves; also whether ground or not); (4) the amount of water used; (5) the temperature of the water; and (6) the period of extraction.

In the preliminary work the material extracted consisted mainly of the stalks and pods of Turkish tobacco, without any leaves, but as the extract produced contained a smaller quantity of nicotine than was deemed sufficient, the raw material was discarded and waste Turkish tobacco leaves substituted.

For the satisfactory control of aphis the Division of Entomology recommends a mixture which will contain from 0.05 to 0.1 per cent. of nicotine; in the case of stalks and pods, however, it was only possible to obtain 0.015 per cent. by using 2lb of waste and 3 gallons of water.

With waste Turkish leaves, however, more encouraging results were obtained, and for the preparation of home-made mixture it would be advisable to use the tobacco waste leaves and water in the ratio of 1 in 10 by weight (viz., 1lb. tobacco to 1 gallon of water, or 2lb. tobacco to 2 gallons water, etc.). When these quantities are used, an extract is obtained which will contain between 0.05 and 0.01 per cent. of nicotine.

Extracts by Cold Water or Boiling.

For the extraction either cold or boiling water could be used. When boiling water is resorted to, five minutes would prove to be ample; for cold water, an extraction period of 3 to 5 hours would be sufficient. Where the tobacco is added to water which has just been boiled and then removed from the flame, a quarter of an hour period can be advocated.

To reduce to a minimum the loss of nicotine by boiling, it is advisable to use fairly large vessels for preparing the home-made extract, For example, if home-made mixtures were to be prepared in a 4-lb. syrup tin, a paraffin tin, and a 20-gallon drum respectively, with the same supply of heat for the same period of time, the loss of nicotine referred to above in original tobacco leaves in the 4-lb. tin would be great, while the amount lost from the 20-gallon drum would be appreciable.

For the control of aphis, the solutions prepared either with boiling or with cold water proved equally effective.

In a cold solution the rate of solubility is considerably accelerated by the degree of fineness of the material; with tobacco dust the maximum solubility takes place after the lapse of two hours.

Although the percentage loss of nicotine *on boiling a large volume of water with* tobacco in the ratio advocated is small, still the same can be reduced to a very small amount by keeping the water at a simmering heat.

When utilising tobaccos containing a larger quantity of nicotine the amount of water used for the extraction can be increased, *e.g.*, with Virginia tobacco (analysing 1.50 per cent. nicotine) the quantity of water can be doubled (*i.e.*, 1 lb. to 2 gallons of water), while with Nicotiana Rustica (2.2 per cent. nicotine) the amount of water can be trebled (*i.e.*, 1 lb. to 3 gallons of water). In using these ratios the final extract will contain between 0.05 and 0.1 per cent. of nicotine.

A Stronger Solution.

A more concentrated extract, which can subsequently be diluted, can be made in the following manner: Into a 20-gallon drum containing 18 gallons of water, 50 lb. of Nicotiana Rustica tobacco are introduced as follows: The water in the drum is heated to boiling and then kept at a simmering heat. Small portions of about 5 lb. at a time are then added to the contents of the drum, which are then thoroughly stirred and allowed to simmer for 5 to 10 minutes. The hot waste tobacco is then removed and dropped into another drum containing cold water. The waste is then squeezed to remove excess water and then discarded. The volume of 18 gallons in the heated drum is kept fairly constant by replenishing the same by additions from the second drum, to which periodic additions of cold water are made. By adopting this procedure it is possible to prepare a fairly concentrated extract, which can subsequently be diluted down. By using 52½ lb. of Nicotiana Rustica tobacco and 21 gallons of water, the writer was able to prepare in the laboratory an extract containing 0.654 per cent. nicotine. This extract would haev to be diluted down ten times with water if it is used as a spray.

The process itself cannot be repeated continuously because the tobacco itself removes about a third more than its weight in moisture. As the solution becomes more concentrated with the later additions of tobacco, the tobacco itself would tend to remove a large amount of the nicotine on withdrawing same from the drum.

These more concentrated solutions, however, do not keep their strength if retained in a drum with a loose-fitting lid. Fermentation and other changes take place which largely diminish the amount of nicotine. A sample of extract which originally contained 0.679 per cent. of nicotine, when allowed to stand for three months and then re-analysed, showed only 0.345 per cent. of nicotine. In other words, nearly half of the valuable nicotine was lost. Perhaps it would be probable that the more concentrated extract would tend to retain its strength if placed into a petrol or paraffin tin, which would then be soldered so as not to admit any air.

Summary of Results.

1. It is possible to prepare a home-made tobacco extract with cold as well as with boiling water.

2. With cold water the rate of solubility depends upon the fineness and quality of the material. With finely ground tobacco dust a period of two hours proves sufficient, while with leaves, 3 to 5 hours would be adequate. When stalks, twigs, leaves, and pods are taken, an overnight soaking will extract the major part of the nicotine.

3. By boiling or simmering, only 3 to 15 minutes are necessary, according to quality of tobacco.

4. Losses of nicotine by boiling are reduced to a minimum by increasing the bulk of the solution and heating so as to keep the water simmering.

5. A more concentrated extract can be prepared by adding successive amounts of tobacco to a boiling-water solution, and the removal of the wet tobacco after being extracted. This process cannot be repeated continuously, as the degree of the extraction obtainable would depend on the nicotine-content of the tobacco.

6. The more concentrated extract (0.65 per cent. nicotine) loses half of its nicotine on standing in a vessel with a loose-fitting lid.

7. Boiling water to which tobacco is added, and then allowed to cool, extracts the nicotine very rapidly.

PROTECTING FORESTS AGAINST DISEASE.

Canadian Government on Fungous Growths.

The need of protecting Canada's forests is now becoming known throughout the country, especially in the direction of protection against fire. Fire is not the only enemy of the forests, however. There is another enemy, probably quite as destructive but not as spectacular. Fungous diseases take an enormous toll of our timber and timber products each year, and the Forestry Branch of the Department of the Interior is actively engaged in solving the problems which these destructive agencies present.

To the majority of men the growth of punks, conchs, or toadstools upon tree, lumber pile, or cellar floor, means little. Their presence, however, is a matter of vital concern to the lumber indnstry, for it proclaims the maturity of plants which have nourished themselves upon food substance supplied by the wood upon which they appear. They are the symptoms of a most advanced stage of timber disease.

The development of this disease is due to fungous action. Fungi are plants and those with which we are concerned here derive their nourishment from woody tissues. The fungous body consists simply of innumerable branching threads of microscopic size, which ramify through the wood, and absorb and assimilate the foods there found. To permit growth, moisture and air must be present and a moderately high temperature is generally necessary, although some growth may occur at low temperature. Having penetrated the wood in all directions the fungous plant is in time sufficiently well nourished to produce its fruits. These are the punks or toadstools, mentioned above, which appear on the wood surface. They indicate a widespread disintegration of the wood upon which they appear, whether it be a forest or a roof timber. Then, fulfilling their purpose, these fruit bodies spread abroad a fine, dust-like clond of spores and disseminate the fungus. Such a cloud may often be noted in moderately still forest air, being gently wafted from the under surface of large woody conchs. Each particle, microscopic in size though it be, carries in it the possibility of further timber infection, for, given favourable conditions for germination, it may in its turn spread destruction through valuable material.

If it be asked how these microscopic spores effect an entrance to forest trees, protected as they are by their heavy covering of bark, the answer is not far to seek. Natural pruning as a tree matnres leaves many broken branch stubs, breaks made by passing animals, the fall of neighbouring trees—these and other agents leave many open wounds which furnish acceptable lodging points for these minute bodies. Spores are not the only means of infection possessed by these destructive plants. The branching threads themselves, may in some forms ramify through the soil and infect roots of neighbouring trees. Or the crossing of roots may cause abrasion and, if one is already diseased, may lead to the infection of the other by simple growth of the fungus into the healthy tissues. This passage of the fungus from diseased to healthy material is perhaps the most frequent source of danger in stored lumber. Cases in point are the decking of logs on infected skids and the careless disposition of infected debris in the vicinity of lumber piles.

General Notes.

REFINING PLANT FOR CANADIAN FELDSPAR MINES.

The Natural Resources Intelligence Service at Ottawa reports that it is reported at Belleville, Ontario, that in the near future a refining mill will be located on the Lake Front to take care of the new feldspar mines in the northern part of the County of Hastings. Most of the feldspar deposits so far located are in Monteagle township. Mica mines in Faraday were recently sold to an English syndicate, which it is expected will erect a plant for grinding mica and build a railroad from the mine connecting with the I.B. and O. in order to facilitate shipping. The output will be marketed in Europe, where it is extensively used in lubricant preparations. "There are other prospects in Bancroft mica area likely to develop industries," said Mr. W. H. Nugent, Commissioner of Hastings County.

CANADA'S MINERAL INDUSTRY CONTINUES TO ADVANCE.

Half-Yearly Report Issued.

According to a statement forwarded to the High Commissioner in London by the Mining, Metallurgical and Chemical Branch of the Dominion Bureau of Statistics at Ottawa, Canada's mining industries showed continued progress in the first half of 1926, and production reports from almost every field pointed to the establishment of new records during the present year.

Valued at $98,395,788, the output of metals and non-metallic minerals including coal, gas and oil, marked an advance of $8,048,090, or 8.9 per cent. over the totals reported for the first half of 1925, and a sum equal to 52 per cent. of the output of such commodities during the entire calendar year 1925.

PROCEEDINGS AND NOTICES OF SOCIETIES.

FARADAY SOCIETY.

Paper read on October 1, 1926:—

Some Physical Properties of Composite Surfaces. By PROFESSOR W. RAMSDEN, M.A.

That adsorbed molecules pass partly out of solution at the free surfaces of aqueous solutions of many tension-lowering solids of high molecular weight is shown by their yielding solid "massed adsorpta" (briefly "M.A.") when, by appropriate methods, the surfaces are "swept up." The molecules concerned are held to be in direct contact with both gas and water. It is theoretically probable that additional molecules are adsorbed in relatively small numbers into the aqueous surface-regions below these.

Some adsorption-surfaces are extremely viscous or even rigid (*e.g.*, saponin and nearly all proteins) and the adsorbed particles must then be in direct mutual contact. Others are freely mobile (*e.g.* quinine and soaps) and the particles must then be either more widely spaced, or so orientated, that only "liquid" cohesions come into operation—far more probably the former. Gelatine is variable and requires complete re-investigation. In the many cases where adequately durable bubble-films are obtainable the interference colours developed as the film gets thinner are disposed in horizontal bands when the surfaces are mobile, but are disposed chaotically when the surfaces are rigid.

There is evidence in the case of saponin that before the adsorption has become too great every molecule of saponin coming into the surface-region is urged to the actual interface and, although still soluble, is kept there permanently. Up to this stage adsorption is in fact "total" and independent of the concentration of the bulk solution. No accurate adsorption-equation can at present be devised, since it cannot at present take into full account the effects of varied orientations and intramolecular strains and of the differences in molecular spacings at different levels of the surface-region.

Nearly all "massed adsorpta" are completely resoluble, but some, *e.g.*, those of egg-albumin and fibrinogen, are insoluble. The change to insolubility is attributed to catalytic condensation of the close-packed specifically strained and orientated protein molecules into a single vast chemical aggregate; activated amino and carboxyl groups of neighbouring molecules uniting by peptide linkages with formation of water. Feeble acidity favours the change but is not essential. Egg-albumin treated with formaldehyde (methylenation of amino groups) yields only soluble "M.A."

Mixtures of a surface-rigidifying solute with a non-rigidifying solute of much greater tension-lowering power, *e.g.*, bile-salt or sodium oleate, have mobile free surfaces. Hence the more tension-lowering solute, although less plentifully adsorbable, appears to be preferentially adsorbed. It is uncertain whether the potentially rigidifying solute is completely excluded from the surface region, since some of it might conceivably become encapsuled in the other solute.

All rigidfying adsorpta spread rapidly to a limit on large water surfaces. If the adsorptum is soluble the surface becomes freely mobile, but if insoluble the surface retains some of its original rigidity. Egg-albumin becomes insoluble within less than five seconds from being placed on the surface.

Interfaces between appropriate aqueous solutions and liquids immiscible with water, and emulsion-interfaces are in some cases mobile and in other cases rigid, alike whether the emulsions are of the oil-in-water or the water-in-oil type. Bancroft's theory of the type-determination of emulsions would require rigidity of the emulsion interface whenever the emulsifying agent was a solid.

All film-coated surface-regions are inherently contractile even when the coating is itself rigid and, when given the opportunity to contract, will pile up the coating into visible masses or, if soluble, allow it to pass back into solution. The so-called "force of compression," regarded by some writers as measuring a thrust exerted on the movable barrier of Langmuir's apparatus, measures the difference between two tractions. The term "force of compression" is in this application misleading and should be discarded in favour of some such term as the "tension-difference."

CHEMICAL, METALLURGICAL AND MINING SOCIETY OF SOUTH AFRICA.

PRESIDENTIAL ADDRESS BY H. R. ADAM.
August 21, 1926.

"Many of my predecessors in the presidential chair of this Society have been in

such close touch with the practical side of the mining industry that a review of the state of the industry from the technical point of view, or a presentation of its problems, has been the basis of a presidential address of interest and value. I cannot, however, claim to come into this category, and the choice of a subject which might justify my addressing to to-night has been a matter of no small difficulty to me. I eventually came to the conclusion that it might be of interest if I discussed for a little one or two problems and processes of importance in mining and metallurgy which, although they may have reached a high pitch of perfection in practice, still await complete explanation from the scientific point of view. It is surprising to find how many phenomena we meet with in every-day work which are by no means thoroughly understood and how many processes and parts of processes there are in daily use which have arrived at practical success by *the method of trial and error.*

Among such processes there are several which depend largely on the obscure phenomena of surface tension or capillarity, and I propose to discuss very briefly a few familiar instances where surface tension, or what has been called by a great authority — Professor F. G. Donnan—" The Physical Chemistry of Interfaces," plays a considerable part. As pointed out by Donnan the application of the study of interfacial phenomena which is of greatest interest is to the living body where surface as opposed to mass is so highly developed; hence the attention paid by physiologists to colloid chemistry. However, we shall find that there are many points in industrial chemistry where surface effects are of very great significance.

We meet with an important case in what is still no doubt our greatest problem, notwithstanding the great progress that has been made. I refer to the elimination of siliceous dust underground. In this distinguished company I am not going to venture far with this question to-night. I merely wish to use this important example to illustrate an effect of surface development, for it is in the relatively large surface extent of the minute siliceous particles in proportion to their fass that most of the difficulty of wetting and settlement lies. We have these minute particles dispersed in a gaseous medium—the air—and they are sufficiently small to illustrate many of the properties of a colloidal suspension. In addition we must remember that on account of our efforts to settle these particles the air contains an enormous number of water particles also of minute size. The practical result is that it is a matter of great difficulty to cause these particles of dust and moisture to coalesce and thus to settle. So much so that one observes the tendency by those in authority to concentrate more on the complete replacement of the dusty air with purer air rather than on further attempts at actual settlement of the dust. What are the causes of the difficulty in wetting and settlement? Without being too definite one may say that one factor is adsorption. Adsorption is an effect of surface energy, and, put in a somewhat crude way, it means that all material surfaces possessing as they do more or less potential energy endeavour to reduce this energy to a minimum. Hence the fact that such a thing as a perfectly clean surface hardly exists naturally. Hence the fact that such a thing as a perfectly *clean surface hardly exists naturally.* Now cohesion generally depends on clean surfaces, so that in a broad and general way we may understand that the adsorption of films of gas or greasy matter or dust and water particles prevent coalescence. We have, of course, other possible factors such as the probability that some at least of the moisture and dust particles carry electric charges of the same sign, and therefore tend to repel each other, but I have perhaps said sufficient on this example to illustrate the importance of sufrace.

Let me pass now to a matter which is interesting metallurgists and chemists in South Africa at the moment, namely, the more or less successful attempts which are being made to extract platinum from ores and concentrates by amalgamation. Why should it be comparatively easy to wet gold with mercury and so difficult in the case of platinum? The success which has so far been obtained seems to depend on the production of hydrogen at the platinum surface. Does the hydrogen remove films of oxide, air or greasy matter? Is the case analogous to the use of flux in soldering, or is there some deeper significance in the effect of the hydrogen? Something associated with the well-known use of platinum as a catalyst in gaseous reactions. Here is an interesting problem for research. At present I use it as another example of a surface effect; of the difficult question of the meaning of the wetting of a solid by a liquid.

In the mining and metallurgical industries the most outstanding application of the relative wetting powers of liquids for solids is that process of mineral concentration known as the flotation process. Here we have a great industry which depends entirely on surface tension phenomena, as yet only imperfectly understood. The rapid development of this process during the last ten or fifteen years has been due almost entirely to the empirical method of try and see. We know that gangue particles which are generally of a siliceous nature are, in comparison with sulphide or metallic particles, easily wet by water, while we have much strong evidence that the latter much more readily become covered by greosy films of extreme tenuity. If we have a mass of ore pulp in this condition and send through it myriads of minute air bubbles so that a relatively enormous liquid air surface is created, there results what is called in flotation a mineralised froth. It is possibly correct to say that the sulphide particles under these conditions become "unwet." We must conclude that by coming to the surface in this way the sulphide particles have issumed the condition of minemal surface energy.

I shall mention only one other example in which the importance of the specific nature of the surfaces concerned is becoming more and more realised. I refer to the question of lubrication which, of course, is of importance in the mining as in all industries. This case is of special interest since it was in the study of the theory of lubrication that Sir W. B. Hardy arrived at the beginnings of what has been called "the chemical theory of capillarity." According to Hardy, friction between relatively smooth surfaces is essentially due to cohesion, and the function of the lubricant is to saturate or satisfy the free surface energies of the two surfaces which cause cohesion and leave, as it were, only the internal friction or viscosity of the lubricant modified by additional effects at the interfaces of the lubricant and the solid surfaces.

As I have already mentioned, there is associated with all surfaces, including the surfaces of solids, a definite amount of surface energy. This follows from the idea that the molecules in the interior of a substance will all, on the average be subject to equal attractive forces in all directions, and the resultant force in any one direction will be zero, while the molecules at the surface are subjected to an unbalanced force, namely, the pull of the interior molecules which keeps the surface in a state of tension. This roughly speaking forms the basis of the classical and purely physical theory of surface tension. It does not, however, lead to any quantitative explanation of well-known specific effects and differences in surface and interfacial tensions of different materials on which depend such important effects as adsorption. Further, the fact that we cannot measure the tension at a liquid-solid or gas-solid interface is the most serious difficulty to progress along purely physical lines. The only measurement that can be made, apart from the surface tension of the liquids, and which is in a sense a resultant of the tensions involved is what is known as the contact angle. It has been shown recently that the measurement of contact angles made by liquids resting against solids is a matter of great difficulty since the state of the solid surface affects the measurements to a great extent.

In concluding what I fear has been a very inadequate attempt to discuss a somewhat abstruse subject perhaps I may take this opportunity of making a few general remarks on our scientific and technical work here which have suggested themselves to me from the matters I have discussed.

First of all it must be obvious that the principles underlying such problems can be best studied in the quiet and disinterested atmosphere of university laboratories. Such studies are not generally undertaken with any other motive than their scientific interest. Even if we consider the matter, however, from the narrow view of the value of such work in the solving of technical problems we cau easily understand its importance. We have therefore in this connection good reason to support as far as we possibly can the progress of research work in our own University and to keep in close touch with its scientific work.

Auother point I wish to make is that such problems as these which lie on the border line of physical and chemical science suggest that our Society, consisting as it does of members experienced in the many branches of mining and metallurgical work, is in rather a unique position in these days of specialisation. We have the disadvantage that many of our papers and discussions appeal only to a section of our membership, but we may remember that our problems can be examined by men of very different experience and special knowledge, and this fact we perhaps do not always make sufficient use of. We have heard much recently

as to the future of Johannesburg and the Witwatersrand and what will happen in the next fifty years or so. If we continue to develop scientific and technical knowledge and make this centre, as it were, the intelligence bureau for all mining affairs in South Africa, we are helping, I think, to make a more stable and powerful community. In such work as this our Society has played a notable part in the past, and I trust will continue to do so in the future."

BY-PRODUCTS IN THE GAS INDUSTRY.

By H. T. Tenen.

Much has been said about the importance of coal as a starting point in the manufacture of a number of products of the highest importance to industry. It remains a fact despite all that has been said, that the real significance of coal has not yet been fully appreciated, not only by the average person but by those who use it in their manufacturing processes. It is still a fact that a large proportion of the by-products from coal are permitted to go to waste.

This is a matter of prime importance yet the manufacturer is often too busy operating his plant and turning out production to give it his attention. At times, for example when the coal strike in the anthracite industry tied up the mines so that those who were accustomed to use hard coal had perforce to have recourse to other fuels, the man in the street had it forcibly brought to his attention that there are other products in coal, in soft coal, if you please, that cannot well be burnt in the ordinary furnace or stove. He was simply made cognisant that there are valuable chemicals which can be derived from coal and which were going to waste in such large amounts, at the same time entailing inconveniences and, under certain conditions, real dangers to public health and sanitation.

It has been said that the future belongs to the nation that can produce the most coal, but it is perhaps just as true, that the manner of utilisation of the coal is as important, if not more so, that the quantity of coal at hand. In the past the American coke industry had been negligent in this respect and this criticism now applies to industry as a whole.

Waste of By-Products.

The valuable by-products that can be derived from coal in a great measure have been allowed to go to waste. Within recent years the development of the by-product coke industry has been very significant, although it has been limited, in recovering the by-products, gas, tar, ammonia, cyanides, that are obtained in by-product chamber plants. The extent of the by-product coke oven industry in comparison with the beehive coke industry can be seen from the following comparison :

In 1915 the total coke production was about 42 million tons, and of this 28 million tons were made in beehive ovens and the remainder, 14 million tons, in by-product ovens. Since then the production of by-product coke has been increasing and in the year 1919 the production of the latter had become greater than that of beehive coke. In 1924 the total production of coke was about two million tons greater than in 1915, but the beehive coke portion of this production was about nine million tons, while the by-product coke amounted to 33 million tons.

By-Products Recovered.

What this means in by-products may be seen from a study of the 1923 figures. In that year about thirty million tons of coal were coked by the beehive method and about 54 million tons by the by-product method. The coke production from the latter consumption of coal amounted to 37.5 million tons. The gas recovered was 601 billion cubic feet, the tar 441 million gallons, the sulphate 1.15 billion pounds, and the benol 105 million gallons. This is a clear indication of the extent of the contribution of the by-product coal carbonisation industry to the general chemical industry of the country.

In discussing the by-products of the gas industry, the situation is somewhat the same as that in the by-product coke industry. The two industries are very closely inter-related. The products obtained in the manufacture of coal gas are the same as those obtained in by-product ovens although the quantities vary per unit weight of coal and the composition of the products also show some variation.

Let us consider first the ammonia by-product. The history of synthetic ammonia is too well-known to require description. To-day it is a very important factor in the

ammonia field. The interesting question, and this is one that has potential significance to the manufacturer of chemicals as well as the gas industry, is what is going to happen to the ammonia liquor that is recovered in the gas works In this case we refer as well to the coke oven plants that make coke oven gas and sell all or part of it to the public. In the year 1924 it has been estimated that the production of ammonia from gas works was 6,700 tons, while that produced by the coke oven plants was as high as 132,000 tons. However, the production of ammonia by synthetic means in the United States in that year was already as high as 4,300 tons, which is almost two-thirds of the gas industry's production.

—*Chemicals*, N. Y.

FORTHCOMING EVENTS.

INSTITUTE OF CHEMISTRY.

The ninth annual Streatfeild Memorial Lecture will be delivered by Mr. F. C. Robinson at the Institute of Chemistry, 30, Russell Square, London, W.C.1., on Friday, November 19, 1926, at 8 p.m. Subject: "The Chemist in the Non-Ferrous Metallurgical Refinery." Professor G. G. Henderson, D.Sc., F.R.S., President of the Institute, in the chair.

Tickets of admission are obtainable on application to the Registrar, Institute of Chemistry, 30, Russell Square, London, W.C.1.

Frederick William Streatfeild was on the staff of the City and Guilds Technical College, Finsbury, from its foundation until his death in march, 1918, as a teacher of applied chemistry. He won the esteem and affection of several generations of Finsbury students, who established a fund for the provision of an annual Memorial Lecture to mark their appreciation of his work and worth.

Previous Streatfeild Memorial Lecturers have been: 1918, Sir William Pope; 1919, Prof. G. T. Morgan; 1920, J. H. Coste; 1921, W. P. Dreaper; 1922, Prof. C. H. Desch; 1923, E. M. Hawkins; 1924, Julian L. Baker; and 1925, Francis H. Carr.

On the closing of Finsbury Technical College, the administration of the Fund and the arrangements of the Lecture were entrusted to the Institute of Chemistry.

ROYAL INSTITUTION.

The following courses of Lectures have been arranged at the Royal Institution during November and December. The Tyndall Lectures will be delivered by Dr. G. W. C. Kaye, who will commence a course of three lectures on the "Acoustics of Public Buildings," on Tuesday, November 2, at 5.15, and on Tuesday November 23, Sir William Bragg begins a course of four lectures on the "Imperfect Crystallisation of Common Things." On Thursday afternoons, beginning on November 4, there will be two lectures by Sir Edgeworth David on "Antartic Exploration Past and Future"; three by Dr. R. R. Narett, on "The Archaeology of the Channel Islands," and two by Sir Squire Sprigge on (I) "Early Medical Literature; and (II) "Medical Literature in Relation to Journalism."

On Saturday afternoon, November 6, at three o'clock, the Rev. E. M. Walker will deliver the first of three lectures on the "Study of History"; on succeeding Saturdays, Dr. G. C. Simpson will give two lectures on "Atmospheric Electricity," and Dr. Cyril Rootham two lectures with musical illustrations on "Henry Purcell and his Contempararies."

The Juvenile Lectures this year, the 101st Course, will be delivered by Professor A. V. Hill on "Nerves and Muscles: How We Move and Feel—(1) Nerves and the Messages They Carry (December 28); (2) Muscles and How They Move (December 30); (3) The Heart and Some other Muscles (January 1); (4) The Lungs and Blood (January 4); (5) Nerves and Muscles Working Together (January 6); (6) Speed, Strength and Eudurance (January 8).

THE IMPERFECT CRYSTALLISATION OF COMMON THINGS.

FOUR LECTURES BY SIR WILLIAM BRAGG ON Tuesdays, November 23, 30; December 7, 14, 1926.

The application of the X-rays to the study of the structure of solid bodies has shown among other things that some regularity of arrangement of the constituent atoms and molecules is vastly more common than has been supposed. Crystallisation is often found to exist in bodies the external appearance of which suggests nothing of the kind. In some cases multitudes of very small

crystals are dispersed in a matrix; in others they are merely jumbled together. *When the body containing the crystallites* is subjected to any process directed in space such as living growth in the case of fibres or bones, or rolling in the case of metals, there is a tendency for the crystals to orientate themselves. Since the physical properties of bodies depend greatly on all the conditions of their crystallisation, a new field of enquiry is opened up in which evidence is sought for as to the manner in which conditions and properties are connected. Already much work has been done in this direction, and something is now known of the crystalline condition of metals, wool and cotton fibres, indiarubber and other substances.

In order that the lectures may be self-contained they will include a preliminary treatment of the properties of X-rays and of crystals in addition to the consideration of the special subject.

THE INSTITUTION OF CIVIL ENGINEERS.

The James Forrest Lecture, 1926, on "Radio Communications," will be delivered in the Great Hall of the Institution, Great George Street, Westminster, S.W.1., on Tuesday, October 26, at 6 p.m., by Senator Gughelmo Marconi, G.C.V.O., D.Sc., LL.D., Hon. M.Inst.C.E.

Prior to the lecture the Kelvin Medal, 1926, will be presented to the Hon. Sir Charles A. Parsons, K.C.B., M.A., D.Sc., LL.D., Eng., F.R.S., M.Inst.C.E.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

Mersey and N. Wales Centre. — The University, Liverpool, at 7 p.m., October 25, the Chairman, Mr. P. J. Robinson, will deliver his address.

ROYAL SOCIETY OF ARTS.

Wednesday, October 27, at 8 p.m.—(Trueman Wood Lecture). Professor Robin J. Tillyard, M.A., D.Sc., F.R.S., Chief of the Biological Department, Cawthron Institute of Scientific Research, Nelson, *New Zealand*, "*Progress of Economic* Entomology, with Special Reference to Australia and New Zealand." Sir Thomas H. Holland, K.C.S.I., K.C.I.E., D.Sc., F.R.S., Chairman of the Council of the Society, will preside.

THE FARADAY SOCIETY.

Ordinary Meeting, Wednesday, October 27, 1926, at 8 p.m., in the Rooms of the Chemical Society Burlington House, London, W.1. The following papers will be read :—"Beryllium," by A. C. Vivian; "The Chemical Constants of the Halogen Hydrides," by F. I. G. Rawlins; "The Decomposition of Nitrosotriacetonamine in Presence of Hydroxyl Ion. Part I. The Region of Small Concentration of Alkali," by J. Colvin; "Latent Heat of Dilution of Sugar Cane Solutions," by Freda M. Hunter; "The Adsorption of Water by *Colloidal Fibres*," by J. J. Hedges; "The Anodic Behaviour of Ferro-Manganese," by A. N. Campbell; "Abnormal Adsorption of Gases by Steel," by T. Carlton Sutton; "The Observation of Cataphoresis in Colourless Sols.—I. Rubber in Benzene," by R. H. Humphry and R. S. Jane; "A Simple Kinetic Theory of Viscosity," by J. S. Dunn; "Condition of Silver Chromate in Gelatin from Electric Conductivity and Diffusive Experiments," by A. C. Chatterji and N. R. Dhar.

NOTICES OF BOOKS.

A Text Book of Inorganic Chemistry. Chromium and its Congeners. By REECE H. VALLANCE, M.Sc. (Birmingham), A.S.C., AND ARTHUR A. ELDRIDGE, B.Sc. (Lond.), F.I.C. Edited by J. NEWTON FRIEND, D.S.C., Ph.D., F.I.C. Pp. XVI + 380. Price 18s. net. London : Charles Griffin & Co., Ltd., 42, Drury Lane, W.C.2.

The present work, which is creditable alike to authors, editor, and printers, is one of a series of books dealing with the great subject of chemistry. In the frontispiece is given the Periodic Table, then follows an exhaustive list of journals with dates of issue. Chapters I.-III. are devoted to Chromium and its Compounds; while Molybdenum is dealt with in IV. and V., and Tungsten and Uranium in Chapters VI. and VII., and VIII.-X. respectively. The name and subject indexes are exhaustive. The book is an authoritative work on the various subjects dealt with, is attractively bound, and merits an extensive sale.

Tables Annuelles de Constantes et Données Numériques de Chimie de Physique et de Technologie. Volume V. 411 + 1130 large 4to pages. Paris : 9, Rue de Bagneux.

The index of the work is given in four languages, set out in four parallel columns

in each page, and the full nature of this index will be understood when we state that it extends to close upon 50 large 4to pages.

Decennial Index of the Analyst. Vols. XII.-L. 1916-1925. Pp. 354. Price 21s. net; or cloth, 25s. Cambridge: Heffer & Sons, Ltd.

We like the make up of this work, and especially the modification of the titles of articles, where such is calculated to facilitate reference. There is given an authors' as well as a subject index. The work will prove a valuable addition to a scientific library.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

24,226.—Auer, L.—Coagulation, etc., of products containing unsaturated carbon compounds. September 30th.

24,218.—Baddiley, J., and British Dyestuffs Corporation, Ltd.—Manufacture of dyes for acetyl cellulose. September 30th.

24,372.—Cassel Cyanide Co., Ltd.—Manufacture of carbon from carbon monoxide. October 2nd.

23,790.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of esters. September 27th.

Specifications Published.

258,641.—Stickings, R. W. E., and May & Baker, Ltd. — Manufacture of organic compounds of bismuth for therapeutic purposes.

235,915.—Larvex Corporation. — Moth proofing composition.

258,704.—Dr. Gross Laboratories.—Process for making pills having an oily material as one of the ingredients.

258,716.—Protz, W.—Method and apparatus for producing and applying fumes or vapours for veterinary treatment.

241,898.—Kunstler, J.—Preserving of sea-water for biological purposes.

258,744.—Cassella & Co. Ges. L.—Manufacture of new organic phosphorus compounds.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

FERRICITE.

471,661.—Chemical substances used in manufactures.—F. Langford Baldwin, 43, Cannon Street, London, E.C.4. October 6th.

SAL-FERRICITE.

472,556.—Chemical substances used in manufactures.—F. Langford Baldwin, 43, Cannon Street, London, E.C.4. October 6th.

UNIVERSITY OF BIRMINGHAM.

LECTURER IN DEPARTMENT OF CHEMISTRY.

Applications are invited for the post of LECTURER IN ORGANIC CHEMISTRY. Stipend, £400 per annum. Duties to begin January 11, 1927, or earlier if possible. Four copies of application, with references must be sent, on or before October 30th, to the undersigned, from whom further particulars may be obtained.

C. G. BURTON,
Secretary.

UNIVERSITY OF MANCHESTER.

CHEMISTRY COURSES.

A Prospectus containing full particulars of the Lectures and Laboratory Courses qualifying for Degrees in Chemistry will be forwarded on application to the Registrar.

The Session commences on OCTOBER 7TH. Applications for admission to the Research Laboratories should be made to the Director of the Chemical Laboratories.

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ON THE CAUSE OF THE GREEN COLOR ASSUMED BY TUNGSTEN TRIOXIDE DURING IGNITION.

By PAUL H. M. P. BRINTON, AND ANNE NELSON LOHMANN.
(School of Chemistry of the University of Minnesota, Minneapolis, Minn., U.S.A.)

In a recent article in this Journal by N. H. Smith and H. S. Lukens[1], it has been shown that the green color developed during the ignition of tungsten trioxide is due to the presence of sodium salts. Experimental results were tabulated in support of this explanation, which was first advanced by Roscoe[2]; but he cited no direct experimental evidence in support of his theory. Von Leimpt[3] attributes the discoloration to the reducing action of dust particles under the influence of light. This subject has been under investigation in this laboratory for some time, and it is believed that some light can be shed on the contradiction in the results of von Leimpt compared with those of Smith and Lukens.

THE EFFECT OF FIXED ALKALI SALTS ON TUNGSTEN TRIOXIDE.

Tungsten trioxide of the highest purity was prepared from wolframite by acid digestion, solution in purified ammonia solution, recrystallisation of ammonium paratungstate, and conversion of the latter to tungstic acid by repeated treatment with purest nitric acid. This gave on ignition for several hours, in a dust-free atmosphere, an oxide of fine yellow color. This oxide was proven free from molybdenum by heating a sample in hydrogen chloride gas at a temperature of 250° C. There was no trace of a sublimate of $MoO(OH)_2Cl_2$. Careful spectroscopic investigation failed to show the presence of detectable traces of sodium or other alkali-metal salts.

Six porcelain crucibles were charged with 3 gram samples of pure tungsten trioxide, prepared as above described, and five of the samples were moistened by the addition of 2 c.c. of 0.05 molar alkali chloride solution, all the alkali elements from lithium to caesium being used. The sixth sample was moistened with 2 c.c. of regular laboratory distilled water for a blank. These samples were then all dried carefully and heated to dull redness for four hours in a muffle furnace.

After cooling, these samples exhibited slight traces of greenish-grey tints, and the depth of this discoloration was the greater the higher the atomic weight of the alkali element. The sample moistened with pure water, however, was judged to be of about the same color as that which had been moistened with sodium or potassium chloride solution. On repeating the heating the order of the colors remained unchanged. It seems likely that the color is not a function of the molar concentrations in this series, but rather a function of the actual amount of alkali chloride added, since this increased from lithium to caesium. It cannot be believed that lithium and sodium have an inhibiting effect on the development of the green colour, so it seems more likely that the colouration is due to traces of impurity introduced with the alkali salts, and even with the water. The lithium and sodium caused only an almost imperceptible change

[1] *The Chemical News*, CXXXII., 32, (1926).

[2] *Ann. d. Chem.* CLXII., 349 (1872).

[3] *Zeitschr. f. anorg. Chem.* CXIX., 310 (1921.)

in the color of the original material, so it is difficult to believe that traces of sodium have the effect on the colour of tungsten trioxide which is attributed to it by Roscoe, and more recently by Smith and Lukens. The latter claim that 0.13% of NaCl give a pale green color to the trioxide, but with 0.2% of NaCl we found no color beyond that in the blank, which can reasonably be attributed to atmospheric dust, as the experiments in our next section will show.

The Effect of Light on Tungsten Trioxide.

It has often been suggested that light caused the reduction of yellow tungsten trioxide to a lower form which was evidenced by the greenish color, thought to be a mixture of the yellow of WO_3 and the blue of the intermediate oxides of the W_2O_5 type. To cite only the more recent work on the subject, von Leimpt[4] claimed that light greatly catalyzes the reducing effect of dust on the trioxide, and that at ordinary temperatures the presence of 1% of sodium chloride will not cause tungsten trioxide to become green by exposure to bright sunlight for a week. If, however, an open tube, which admits atmospheric dust, is used, the trioxide similarly exposed, but with no sodium present, will turn a pale greenish yellow. Smith and Lukens[5], on the other hand, state that light has but very little effect on the oxide, and that without sodium salts present there will be no change of color.

Preliminary experiments in this labouratory had shown that two causes of the green color were most probable. First, the presence of ammonia, or more probably traces of nitrogenous substances remaining after the ignition of the ammonium compounds; and secondly, light.

To get more definite information, the following experiments were carried out :

(1) Yellow tungsten trioxide which had been ignited to dull red heat was exposed to the ultra-violet rays of a mercury vapor lamp. The sample was in a quartz flask, which would protect it from dust, and still allow the passage of the ultra-violet rays. Exposure for up to twenty hours caused no visible change.

(2) A sample of the same material was exposed to the mercury vapor lamp on an open porcelain plate in a quiet room. This sample turned a very decided green. This shows the sensitivity of the oxide to dust; and a blank run with the same exposure to diffused daylight instead of to the ultra-violet days showed that the strong actinic rays have a most pronounced activating influence on the reduction.

(3) A sample of pure yellow trioxide was moistened with re-distilled ammonia, and ignited to dull red heat to expel the ammonia. One half of this was exposed to the mercury vapor light on an open plate, while the other half was kept in ordinary daylight for comparison. That which had been exposed to the ultra-violet light turned a very deep green, while the blank showed an almost imperceptible change.

It seemed clear, then, that the most intense coloration of the trioxide came from the simultaneous action of strong light, especially the ultra-violet, and a reducing agent, such as dust or a nitrogenous residue from ammonia.

(4) As confirmatory test, the sample used in (1) in the quartz tube which had withstood the effect of the mercury lamp for twenty hours, was again exposed in the same vessel, but during this exposure a gentle stream of air was drawn through the quartz flask. Although this was in a quiet room, unoccupied by others, the dust drawn through the quartz flask was sufficient, under the influence of the ultra-violet light, to color the surface of the oxide a purplish green.

Summary.

It seems quite evident from the experiments here recorded that the influence of sodium in producing a green color in tungsten trioxide is negligibly small in comparison with that of a trace of reducing matter under the influence of strong actinic light rays.

[4] Loc. cit.

[5] Loc. cit.

SEARCH FOR MISSING ELEMENTS—A REPLY TO THE CRITICISMS OF W. PRANDTL, OF WALTER AND IDA NODDACK, AND OF OTHERS.

By F. H. Loring.

It would appear from the various criticisms of our work[1] that the above investigators had not been acquainted with all our communications. For example, W. Prandtl[2]

says that our X-ray lines are due to Zn and W. Our negatives showed no tungsten lines and if there was such a feeble line as the $WL\beta_8$ (of wave-length in Angstrom units 1.2354)—which Prandtl believes was the line we attributed to $75L\beta_1$ ($\lambda=1.2358$) then Prandtl should explain how it was that the stronger tungsten lines that fall in the region explored did not appear on our negatives.

Prof. Prandtl's statement that we claim to have discovered elements of atomic numbers 85, 87 and 93 does not harmonise with the several disclaimers we have made. In our publications we recorded all our lines and tried to identify them. The best we could do was to regard 75 and 87 as more clearly foreshadowed, bu t we admit (at least the present writer does) that more work is necessary to establish these elements beyond any possible doubt.

With regard to W. and Ida Noddack's[3] criticism, they say that our lines are: $ZnK\alpha_1$ and $HgL\alpha_1$.

The mercury spectrum was a serious problem in our case, but the absence of the $HgL\beta_1$ line ($\lambda=1.0458$) on a negative, *which was good in every way, showing* fairly strongly the lines corresponding with the $L\alpha_1$ and $L\beta_1$ lines of element 75, made it difficult to see how so pronounced a line, as agreeing with the $L\beta_1$ of 75, could have been present solely as the $HgL\alpha_1$ line without the $HgL\beta_1$ line being also present as one slightly weaker, since the $L\alpha_1$ and $L\beta_1$ lines in general are not greatly different in intensity—say, as 10 is to 8.

This was discussed by the present writer when further tests were made and published soon after the earlier papers.[4]

To reconcile these discrepancies, or observations, it would appear that the two strongest characteristic lines of element 75 were sufficiently coincident with the $ZnK\alpha_1$ and the $HgL\alpha_1$ lines to build thereon and give in consequence a spectrum of false intensity, which led us to believe that there was an appreciable amount of 75 in our end product. This would also explain why the $75L\beta_2$ line was not seen on one good negative in particular, and also account for the absence of the $HgL\beta_1$ line on the same film, as the exposure covered the region of this line, extending to the Br-Ag absorption edges.

In *Nature*, December 26, 1925, p. 943, a criticism appeared—the first one. Here, too, there seems to have been a misunderstanding for we did not claim to have discovered all the elements cited (see answer by present writer to this criticism in *Nature*, January 30, 1926, p. 153). Here also our lines were attributed to zinc and mercury; but, as stated above, subsequent experiments made the $HgL\alpha_1$ line difficult to account for, since the $HgL\beta_1$ line (the next in intensity) did not appear on the negative. The superposing of lines, or corresponding radiations, as just stated, explains this.

In the *Chemical Reviews*, two joint writers[5] refer to the above comments in *Nature*, saying that a number of discrepancies appeared in our statements. It is true that some of our statements left much to be desired, but that can be said of several of the papers which have appeared on the subject since our first publications. This discrepancy arose partly from the physical side and the chemical side being kept apart. We seemed to have got a good deal of 75—at least on one or two occasions—and not wishing to prejudice the *chemical* findings, they were allowed to stand, even without proper support from the *physical* or X-ray side.

The possibility of a 75 compound being volatile or not remaining long enough on the anticathode of the X-ray tube to register lines made it necessary to avoid prejudicing the chemical part with X-ray findings of a negative character.

From unpublished experiments recently made with a common volatile substance on the anticathode, this failure of lines to record, owing to the feebleness of the radiation, is experimentally proved to be possible. In this case it is believed that volatile compounds were present.

Whether any of the elements in question can be made up in the X-ray tube[6] is still uncertain, but experiments are being made with a view of clearing up this possibility. Some results have been obtained clearly indicating a process of element formation precisely as indicated[6], but until full particulars are published this statement must be treated as of no significance.

We appreciate and respect the work that has been done by others in the same field, and it is hoped that these explanations will be accepted in the kindly spirit intended, as the problem of isolating the missing elements is a difficult one.

REFERENCES.

[1] J. G. F. Druce, *Chem. News*, 1925, vol. CXXXI., p. 273; Loring and Druce, *ibid.*, pp. 289, 305, 321, 337; Loring, *ibid.*, p. 371.

[2] W. Prandtl, *Zeit. angew. Chem.*, 1926. vol. XXXIX., p. 1049; complete translation in *Chem. News*, 1926, vol. CXXXIII., p. 225.

[3] W. and Ida Noddack, *Metallbörse*, 1926, vol. XVI., p. 2129; complete translation in *Chem. News*, 1926, vol. CXXXIII., p. 241.

[4] Loring, *Chem. News*, 1926, vol. CXXXIII., p. 101.

[5] T. J. Patton and L. J. Waldbauer, *Chemical Reviews*, 1926, vol. III., p. 81—see pp. 89-90.

[6] Loring, *Chem. News*, 1926, vol. CXXXII., p. 311; see also *ibid.* p. 407 see Note V.

General Notes.

SILK FROM CANADIAN TREES.

When we gaze on a great forest tree it is not easy to visualise it in the terms of rich cloth and silken raiment. And yet man, not content with silk, cotton, wool, linen, and a number of lesser sources of clothing material, now employs wood for the manufacture of the latest of the textiles—artificial silk, or rayon, as it is called by the trade. The basis of all artificial silk is cellulose, and cellulose is the principal constituent of wood.

As long ago as 1879 Count Hilaire de Chardonnet produced artificial silk commercially, but it has taken many years of incessant labour to bring the various processes to that stage of perfection which is essential to commercial success. That the industry has now become a great undertaking is shown by the fact that the world's production in tons has arisen from 7,500 in 1909 to an estimated 100,000 for this year.

Principle of Process.

The general principle underlying the manufacturing methods is the treatment of the cellulose with chemical re-agents to give a gelatinous solution which can be forced through a number of minute nozzles into a bath of solution (or in one process into air). This solution causes the coagulation of the liquid emerging from the nozzles and thus creates the actual filaments of artificial silk, though the material has to pass through several other stages, varying with the process, before it finally emerges as that glistening transparent gossamer to which we are now so accustomed, but which would have amazed many a nineteenth-century grandmother.

The possibilities for rayon manufacture in Canada, with her vast pulpwood areas, are enormous. The countries which were first to develop the industry, however, were not those which possessed much raw material, but those which already had the organisation, the equipment and the markets for a big textile industry. Thus, shortly before the war, France, already predominant in the manufacture of natural silk, took the lead, followed by Switzerland. Now the big producers and exporters are the United States, Great Britain, and the countries of Central Europe that are prominent in the natural silk trade.

Recent Developments in Canada.

For a good many years Canada has supplied much of the sulphite pulp used for that purpose in these countries. In 1922 the Natural Resources Intelligence Branch of the Department of the Interior published a report drawing attention to the unusually favourable conditions for the development of artificial silk manufacturing in its entirety, within the Dominion. The following year, Messrs. Courtaulds, Ltd., the largest rayon manufacturers in the United Kingdom, sent engineers to Canada to investigate these representations, with the result that a plant was established in Cornwall, Ontario, in 1924, at a cost of $2,500,000.

This would appear to be but the preliminary of many others. Canadian Celanese, Ltd., capitalised at $7,000,000, is now constructing a large plant at Drummondville, Quebec; and the Howard Smith Paper Mills have formed a subsidiary company called the Canadian Cellulose Company, which will also be operated at Cornwall. The British Columbia Pulp and Paper Company, formerly the Whalen Pulp and Paper Company, operating pulp mills in British Columbia, has been carrying on chemical research for some time in the utilisation of hemlock for the production of cellulose and certain results and conclusions have been reached which, it is stated, may determine the company to proceed with installation of a new plant for the manufacture of this sort of pulp. Many other companies variously located from the maritime provinces to the Pacific Coast are also taking steps or considering means to enter this field

which is so profitable, so large, and which Canadian resources, both of wood reserves and natural power supplies, are particularly adapted to support.

UNITED STATES MINERAL PRODUCTIONS.

Pennsylvania, with its enormous coal output, led all the States in the production of minerals in 1924, the latest year for which complete figures are available, according to the Bureau of Mines, Department of Commerce. The Commonwealth's mineral production in that year amounted to $1,011,630,879, and constituted 21.64 per cent. of the nation's entire mineral output. In addition to coal, the State was a large producer of cement, clay products and natural gas. California ranked second as a mineral-producing State, its tremendour production of petroleum, natural gas, cement and natural-gas gasoline comprising the bulk of its mineral output valued at $428,175,652. Oklahoma, with production valued at $393,030,665, made up largely of petroleum, zinc, natural gas and natural-gas gasoline, ranked third.

West Virginia, whose coal, natural gas, petroleum and clay products constituted the bulk of its mineral production valued at $307,729,023, being largely comprised of petroleum, sulphur, natural-gas gasoline, and natural gas.

The relative rank of the other leading States, with the minerals constituting the bulk of their production, is indicated in the following table :

Ohio—Clay products, coal, natural gas, petroleum—$249,049,648.

Illinois—Coal, clay products, petroleum, cement—$235,796,027.

Kentucky—Coal, petroleum, clay products, natural gas—$120,510,775.

Michigan—Iron ore, copper, cement, clay products—$114,239,386.

Indiana—Coal, cement, stone, clay products —$112,299,075.

Minnesota—Iron ore, cement, stone, clay products—$107,844,680.

Kansas—Petroleum, zinc, coal, natural gas —$105,005,476.

Arizona—Copper, gold, silver, lead—$100,325,413.

RESEARCH ASSOCIATION OF BRITISH PAINT.

The Secretary of the Department of Scientific and Industrial Research begs to announce that a license under Section 20 of the Companies (Consolidation) Act, 1908, has been issued by the Board of Trade to the Research Association of British Paint, Colour and Varnish Manufacturers which has been approved by the Department as complying with the conditions laid down in the Government Scheme for the Encouragement of Industrial Research.

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GYPSUM IN WESTERN CANADA.

The gypsum industry in Western Canada has been showing steady improvement during the past year and a half, a development not entirely unexpected in view of increasing activity in the building trades.

NEW ESTIMATE OF ALBERTA'S (CANADA) COAL RESOURCES.

The Natural Resources Intelligence Service at Ottawa reports that Professor John A. Allen, of the Geological Survey Division of the Scientific and Industrial Research Council of Alberta, has arrived at some new figures on the coal reserves of that Province. The total coal resources computed on the basis of the Kootenay, Belly River and Edmonton formations has previously been given as 1,072,400,000 metric tons. Professor Allen has taken into consideration data available last year on the actual and probable coal lands in each of the coal areas to a depth of about 1,000 feet, taking in seams of more than two feet in thickness. As a result he gives the coal reserves of Alberta as 327,663,360,000 metric tons, or about 304 times more than formerly considered. Considering only 50 per cent. of this as recoverable, the coal actually available for use is about 30 times more than the amount of coal formerly considered available and unavailable.

CHEMICALS AT THE FAIR.

Despite the holiday season and the serious effects of the coal stoppage, applications for space in the London Section of the British Industries Fair, which is to be held at the White City from February 21 to March 4 next, have been reaching the Department of Overseas Trade daily. The total area applied for already considerably exceeds the whole area occupied at the last Fair, and there is every indication that additional buildings will have to be linked up with those previously used. Early arrangements will have to be made for any such extension, however, and firms are advised to make their requirements known at once.

WHOLESALE PRICES IN FRANCE, BELGIUM, GERMANY AND ITALY.

The general levels of wholesale prices in August in France and Belgium were substantially below the July levels. German wholesale prices showed practically no change, while the general index in Italy at the end of August was 2.2 per cent. above the figure at the end of July. Owing to the employment of different base periods the index numbers are not strictly comparable in magnitude as between one country and another, but some comparison can be made regarding the relative movement of prices.

The general index number of French wholesale prices, which rose from 645 at the end of March to 854 at the end of July, shows a sharp fall in prices during August, the end-of-month figure being 785.

The foodstuffs index, which opened the year at 528, rose without break to 703 at the end of July, but the August figure shows a decline of 4.4 per cent.; the "vegetable" group fell by 5.4 per cent., and the "animal" group by 1.4 per cent.

Industrial materials also cheapened during August, the index at the end of the month being 885 against 985 a month earlier. The greatest fall (18 per cent.) was recorded in the textile markets, while minerals and metals fell by 10.3 per cent., and "miscellaneous materials" by 3.7 per cent.

The average level of German wholesale prices, which had pursued an upward course since March, receded slightly in August, but was still about 6 per cent. above the January average.

Notwithstanding the strong appreciation in grain prices in the second half of August, the "cereals and potatoes" index for the month was below the July level, this being the first decline (on monthly average) since February. The August index for foodstuffs of animal origin, with which sugar and fish are included, was 136.5 against 132.3 in July, the increase being in part due to usual seasonal movements of cattle and sugar prices.

AUSTRALIAN TRADE IN AUGUST.

The Official Secretary to the Commonwealth of Australia in London reports that the total value of the goods imported to and exported from Australia during August were as follow :—

Exports—

	£
Australian Produce	76,61,335
Other Produce	213,098
Total	7,874,433
Imports	14,591,101

SPECTROMETERS, ETC.

Messrs. Adam Hilger, Ltd., of 24, Rochester Place, Camden Road, London, N.W.1., whose reputation for optical

spectroscopic apparatus is world-wide, have issued a new catalogue of wave-length spectrographic apparatus is world-wide, ialised spectroscopes (Section D.). The Hilger wave-length spectrometer—constant wave-length deviation type — containing Pellin and Broca's design of prism, is first described. Then follow accessories, including a replica of Rowland's diffraction grating. Thermopile attachments, with infra-red accessories, renders the instrument used suitable for absorptions of aqueous solutions in the infra-red region. A cheaper spectrometer, reading in wavelengths direct to an average accuracy of 1.5 Angström units, is described. On page 19 there is a special spectroscope for the rapid detection of Ni, Cr, Co, and other specified metals, in steels and alloys. On pages 20 and 21 a simple ultra-violet spectrometer is shown. "On the fluorescent screen may be observed the whole of the visible, and ultra-violet spectrum down to about 1850 A." There are other instruments such as Dr. Tutton's spectroscopic monochromatic illuminator, illustrated and specified. Cameras are also shown attached to some of the instruments.

Newness in idea is not always so much to be sought as perfection in detail, but both are characteristic of the productions of Messrs. Adam Hilger, Ltd., and of course accuracy of workmanship is assured.

THE INSTITUTE OF CHEMISTRY OF GREAT BRITAIN AND IRELAND.

SEPTEMBER-OCTOBER EXAMINATIONS.

PASS LIST.

EXAMINATION FOR THE ASSOCIATESHIP IN GENERAL CHEMISTRY.

Allison, Cowan (Technical College, Paisley); Dixon, Frederick, B.Sc. (Leeds) (The University, Leeds); Gillam, Albert Edward Maxwell George (Central Technical School, Liverpool); Palmer, Herbert John (Sir John Cass Technical Institute and King's College, London); Pollard, Robert, A.M.C.T. (College of Technology, Manchester); Reid, John Wardlaw (Chelsea Polytechnic); Robinson, Adeline Joan, B.Sc. (Lond.) (University College, London); Savage, Ronald Henry Maxwell, B.A. (Cantab.) (The University, Cambridge); Tarbert, David John, B.Sc. (Lond.) (Trained under G. E. Johnson, Esq., F.I.C., at the Municipal Technical School, Hull; Tayar, Robert Alfred Victor (Municipal Technical School, Birmingham); Thomas, Edward Boaden, B.Sc. (Lond.) (Birkbeck College); Todd, James Ross, B.Sc. (Lond.) (Heriot-Watt College, Edinburgh, and Northern Polytechnic Institute, London).

In Branch (g): Chemical Technology with special reference to low temperature carbonisation—Muddiman, Ernest Walter.

EXAMINATION FOR THE FELLOWSHIP.

In Branch A: Inorganic Chemistry, Section I, Mineral Products—Rogers, Cecil William, B.Sc. (Lond.).

In Branch C: Organic Chemistry—Nisbet, Hugh Bryan, B.Sc. (Edin.).

In Branch E: The Chemistry (including Microscopy) of Food and Drugs, and of Water—Butler, John, B.Sc. (Liv.); Roberts, Muriel, B.Sc. (Liv.); Snelus, Suzanne Mamel Lavinia.

In Branch F: Biochemistry with special reference to Vitamines—Wokes, Frank, B.Sc. (Liv.).

In Branch H: General Chemistry—Peace, Gordon.

In Fuel Technology, with special reference to Coal and its derivatives—Taylor, Robert Arthur Acton, M.Sc. (Lond.), A.R.C.S.

RICHARD B. PILCHER,
Registrar and Secretary.

22nd October, 1926.

GREAT CHEMICAL MERGER.

The recent unusual activity in the shares of several large chemical companies was explained last week by the official announcement that four companies, with a combined issued share capital of £43,500,000, have arranged to join their interests. The companies concerned are Brunner Mond and Company, Ltd., The British Dyestuffs Corporation, Ltd., Nobel Industries, Ltd., and The United Alkali Company, Ltd. The shares have improved in value during the past three weeks to the extent of over five millions in the aggregate, so that some of the shareholders have done pretty well financially. It is surmised that a new company will be formed, as the simplest method of completing the arrangement.

Sir Alfred Mond, M.P. (head of Brunner Mond, Ltd.), has made the following statement:—

"The formation of great combinations such as the I.G., the Steel Trust, and similar combinations in Germany and other parts of the Continent, the existence of great

chemical groups such as the Allied Chemical of New York, and Du Ponts, and other great combinations in America, has forced the leaders of the chemical industry in this country to consider the relative position of their individual concerns and of the industry as a whole. After very careful consideration of all the relative circumstances, they have come to the conclusion that the time has arrived for the British and Imperial chemical industry to endeavour to form equally a united front. As strong as the units of the combination undoubtedly are, and capable of operating in the future, as in the past, with profit to their shareholders, and with benefit to the country, it was still felt that by union still greater efficiency, both commercially and technically, could be obtained for the development of existing, and the creation of new, chemical industries, with advantages of saving any unnecessary expenditure of capital by duplication and overlapping. Operating as they are, not merely in this country, but throughout the Empire and the markets of the world, related as they are not merely as producers but also consumers of each other's products, the advantages of as close and intimate a relationship as it was possible to create was felt by all concerned.

CONTRIBUTION TO THE SEROLOGIC GROUPING OF BACILLUS DYSENTERIÆ BASED UPON THE QUALITY OF ANTIGEN AND NORMAL AGGLUTININS.

By Otto Schöbl and Rita Villaamil.
(Of the Division of Biology and Serum Laboratory, Bureau of Science, Manila.)

(*Philippine Journal of Science*, Vol. XXX., No. 1.)

As a diagnostic method the agglutination reaction is one of the oldest immune reactions known. The well-known Gruber-Vidal reactions for the diagnosis of typhoid fever has been used for practical purposes, and the principle on which this method is based was in its time applied to serodiagnosis of other bacterial infections.

The identification of isolated strains (intestinal pathogenic bacteria, in particular) by means of agglutination is the most convenient and generally used laboratory method. With the view of specificity, however, research on agglutinins was mainly devoted to the study of immune agglutinins. The normal, or natural, agglutinins have had a theoretical interest only. Bürgi in 1907 admits that very little research has been done on normal agglutinins. His is the most exhaustive study found in the available literature; it includes normal sera from numerous animals and a long series of various micro-organisms—among others, *Bacillus dysenteriæ*.

In the course of systematic study by several members of the staff of the Bureau of Science concerning the bacteriology and immunology of bacillary dysentery it became desirable to secure information as to the agglutination of *B. dysenteriæ* by normal sera of various animals, possible donors of agglutinant sera. Therefore, the investigation here discussed was carried out. In the course of the investigation concerning the presence or absence of agglutinins toward *B. dysenteriæ* (both the Shiga and the Flexner types) in normal sera of laboratory animals, a constant phenomenon was encountered when the serum of normal rabbits was used. This finding was considered of sufficient interest to warrant further investigation of the phenomenon.

Summary.

Two types of *Bacillus dysenteriæ*, Shiga and Flexner were subjected to agglutination tests by normal sera of the following animals: Guinea pig, rabbit, horse, mule, goat, sheep, and monkey. It was found that the sera of horse, mule, sheep, and goat agglutinate both the Flexner and the Shiga types of *B. dysenteriæ*. The rabbit serum behaved peculiarly, inasmuch as it agglutinated promptly all the Flexner strains available, forming large flakes and firmly packed sediment.

The majority of the Shiga strains available (that is, strains isolated locally from patients and carriers as well as cultures obtained from abroad) were non-agglutinable hy normal rabbit serum, while a smaller number of Shiga strains were agglutinated by normal rabbit serum. The largest number of the latter were agglutinable by boiling.

In the adsorption experiments the Flexner type adsorbed the agglutinins for the corresponding strains regularly, from normal rabbit serum, whereas the Shiga strains showed irregular results; that is, serum adsorbed by the Shiga strains did not adsorb the Flexner agglutinins, whereas sometimes it agglutinated the Shiga strains and sometimes it did not.

In view of the character of the agglutinate (that is, mostly small flakes and loose sedi-

ment) and in view of the irregularity of adsorption and, particularly, of the fact that the majority of these Shiga strains are agglutinable on boiling, the agglutination of Shiga strains in general by normal rabbit serum is believed to be due to the quality of the antigen of certain strains rather than to the presence of real agglutinins such as one finds for Flexner strains in normal rabbit serum.

Our smaller group of mannite non-fermenters agrees remarkably with the small group in our collection which was found to represent a serologic small group when monovalent serum was used and to produce indol, thus resembling the Flexner strains in this respect (Lacy). The small group was found to be agglutinable by the polyvalent immune horse serum to a higher degree than were the regular strains, although the regular strains were used exclusively for the preparation of the serum.

The majority of the small group (that is, the strains agglutinable by normal rabbit serum) were found to be spontaneously agglutinable on boiling for one hour in a suspension of salt solution. There were, however, some members of this group that were agglutinable by normal rabbit serum, but were not agglutinable on boiling.

When the adsorption test of the polyvalent immune horse serum was performed the regular strains showed reciprocity in complete adsorption of agglutinins within their group and adsorbed partially the agglutinins for the irregular strains. The member sof our small group adsorbed partially their own agglutinins but did not adsorb the agglutinins of the regular strains. Two strains were encountered that were agglutinable by normal rabbit serum, but not on boiling, and which adsorbed partially agglutinins for both the regular and the irregular Shiga strains, thus forming an intermediate stage between the regular and the irregular strains. It is interesting to note that these strains, according to the classification by monovalent serum, belong to the larger group (Lacy). Another strain, spontaneously agglutinable in salt solution suspension, adsorbed neither for the regular nor for the irregular strain, thus forming the extreme end of the serological stages of mannite non-fermenters. In agreement with this serologic grouping by the use of qualitative antigen analysis and normal agglutinins, the regular Shiga strains showed a narrow, sharply defined zone of agglutination when subjected to the acid agglutination test; that is, the agglutination was restricted and most pronounced in the solutions of highest ion concentration. The irregular Shiga strains, that is, agglutinable by normal rabbit serum and agglutinable or non-agglutinable by boiling, showed as a rule a more pronounced agglutination not infrequently extending over all of the six solutions used.

The mannite fermenters on the average showed a similar optimum of acid agglutination as did the non-fermenters, but the range was somewhat wider than that in Shiga strains.

DISCUSSION.

If we consider the findings presented in this paper and use them as a basis for interpretation of the serological grouping of mannite non-fermenters, as offered by Lacy, we can hardly escape the impression that the gradual degeneration of the antigen of the bacteria of one group is responsible for the differences in agglutinability of the various strains and the consequent serologic grouping.

As rightly pointed out by Lacy the preliminary test of identification of *Bacillus dysenteriæ* by agglutination with monovalent agglutinant serum is not advisable, inasmuch (as Lacy has shown) as the small group would have escaped the attention of the bacteriologist diagnistician. From our results, however, it can be seen that the polyvalent antidysenteric horse serum, as prepared for us by therapeutic purposes and used as a preliminary identification test of suspicious colonies on plates, agglutinates the members of the small group to at least as high a degree as its homologous strains and frequently to a much higher degree.

In our experiments the regular Shiga strains were found resistant to agglutination by serum of their own to a higher degree than were the irregular ones. The sensitiveness to agglutination of the latter by the serum of the former is expressed by their being more highly agglutinable by the serum of the regular strains than are the regular strains themselves. This is further emphasised by the fact that they are agglutinable by normal rabbit serum and more so by the fact that the majority of the strains are agglutinable on boiling for one hour.

Thus we have a series of stages of susceptibility to agglutination from the regular Shiga strains that are comparatively slightly agglutinable by homologous immune horse serum, non-agglutinable by normal rabbit serum, and non-agglutinable on boiling;

have a sharply defined optimum of acid agglutination restricted to the solutions of highest ion concentration; adsorb completely agglutinins of their own as well as of all members of their group and adsorb partially those of the irregular strains of mannite non-fermenters, to the extreme other end, represented by the spontaneously agglutinable strain so susceptible to agglutination that the mere presence of the small amount of sodium chloride in physiologic salt solution will bring about agglutination. All degrees of gradual degeneration are represented in our collection, between the regular strains and the spontaneously agglutinable strains. There are strains which agglutinate by rabbit serum only and not on boiling and have a wide range of agglutination in the acid agglutination test, and those which agglutinate on boiling as well as by rabbit serum and show high susceptibility to acid agglutination. Some of these adsorb their own agglutinins and those of their group, while others behave with respect to adsorption as well as to acid agglutination in exactly the same manner as does the spontaneously agglutinable strain.

Hand in hand with the increase of susceptibility to agglutination there goes a decrease in their adsorbing capacity. We find that an immune horse serum prepared with the regular strains agglutinates all the Shiga strains in our collection; but the adsorption experiment shows the fine serologic distinction between the two groups. In connection with these observations we must not omit to mention the findings of Morishima who, working in the Bureau of Science on the constancy of types of *Bacillus dysenteriæ*, found that the serum prepared by the original mother culture agglutinated itself as well as the variant. The serum prepared by the variant agglutinated the variant itself and the mother culture; but, while the mother culture adsorbed agglutinins of its own as well as those for the variant, the variant adsorbed the agglutinins for itself only, but not those for the mother culture.

It is evident that there is a partial loss in the receptor system of certain serologic groups of *Bacillus dysenteriæ*, while the changes as noticed by Morishima in mannite fermenters were not only serologic, but also cultural, inasmuch as it was possible to change the "Y" type into a Flexner type and *vice versa*; it was impossible to induce mannite non-fermenters to change their fermenting properties. In our case the only explanation is that the irregular strains of mannite non-fermenters have gradually variated, but the mannite non-fermenters, being very stable as far as fermentation of carbohydrate is concerned, gradually and partially lost their adsorbing receptor system but retained their fermentative properties intact. The grouping of our collection into serologic groups by Lacy finds its explanation in our experiments and in those of Morishima.

In accordance with the receptor theory of Ehrlich, we have to assume three systems of receptor; one, which causes the emulsion to agglutinate when brought in contact with immune serum; another, which adsorbs the agglutinins from the immune serum; and a third, which stimulates the production of agglutinins when injected into the animal's body (agglutinogen).

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE CHEMICAL SOCIETY.

Papers read on October 21, 1926.

Examination of an Ancient Egyptian (Tutankh-Amen) Cosmetic. By A. Chaston Chapman and H. J. Plenderleith.

A brief description of this fatty material was given. It was found in an alabaster vase in the tomb of Tutankh-Amen, which had remained sealed for 3300 years.

The Density of Boron Trichloride and the Suspected Variation in the Atomic Weight of Boron. By H. V. A. Briscoe, P. L. Robinson and H. C. Smith.

Three specimens of boron trichloride used in the determination of the ratio $BCl_3 : 3\ Ag$ were subjected to purification by vacuum distillation and their densities were compared by the use of calibrated glass floats, the relative atomic weights of the three samples of boron being deduced therefrom.

The Formation of Protective Oxide Films on Copper and Brass by Exposure to Air at Various Temperatures. By W. H. J. Vernon.

Clean copper surfaces may be protected from tarnishing hy a short heat-treatment in air. The protection is considered due to the formation of a film of suprous oxide, either so thin as to be practically invisible, as when produced between the limiting temperature (55-75°) and 100°, or sufficiently thick to give rise to interference colours, as

when produced between 100° and 200°. The limiting temperature probably depends on the formation of a film of minimum thickness such that the unit lattice of the oxide is complete over the whole surface. A similar practically invisible oxide film may also be obtained by about a month's exposure at the ordinary temperature, providing the air is sufficiently pure. At constant temperature (up to 250°) there is a parabolic relationship between weight-increment and time, whilst for constant time of heating the rate of oxidation increases with temperature, according to J. S. Dunn's equation.

With 60 : 40 brass, a protective effect has been observed consisting mainly in the suppression of further colour changes on subsequent exposure.

The action of Antimony trichloride on Some Diazotised Diamines. By W. H. GRAY.

Antimony trichloride forms sparingly soluble crystalline additive compounds $(CH_3.CO.NH.C_6H_4.N_2Cl)_2$, $SbCl_3$ with diazotised acetyl-*m*-phenylenediamine and acetyl-*p*-phenylenediamine; the former resembles the compounds with benzene- and toluene-diazonium chlorides discovered by May, immediately losing the diazo-nitrogen on warming with dilute acid. The *para*-compound behaves exceptionally. On boiling with hydrochloric acid it forms a stable, still less soluble, additive compound, p-diazoiminobenzene hydrochloride-antimony trichloride.

The antimony is quantitatively removed from these compounds by cold water, and the organic portions of these compounds have been isolated. The former yields *p*-acetamidobenzenediazonium chloride, the latter a hydrochloride of the hypothetical *p*-diazoiminobenzene.

The Formation and Stability of Associated Alicyclic Systems. Part III. The Change from "Meta"- to "Para"-Bridged Rings. By E. H. FARMER AND J. ROSS.

The very diverse products (open chain, monocylic, dicylic) obtained by the "Michael" addition of esters to 1-methyl-Δ^1-*cyclo*hexen-3-one, illustrate a capacity for the formation and ready disruption of "meta"- and "para"-brigded rings. The formation of a bridge and the type of bridge formed depend on the gronps of the addendum and the conditions existing during the "Michael" addition. The divergent tendencies towards the formation of "meta"- and "para"-bridges are compensated by difference in the constitutions of the bridges.

Changes from "meta-" to "para"-attachments can be brought about, but the reagents which accomplish this are also capable of causing disruption of the newly formed systems. Hence, in some cases the intermediate existence of a bridged ring can only be recognised by the nature of the fission-products actually obtained.

CORRESPONDENCE.

A LEATHER QUERY.

(*To the Editor of the* CHEMICAL NEWS.)

Sir,

Can you or any of the readers of your journal tell me the name of a substance which will unite any two pieces of leather together so that it cannot be pulled apart and will also withstand heat, and where I might obtain such a substance. Or of the chemicals which would make same and the method of mixing. If so, I should be greatly obliged.

Thanking you in anticipation.

Yours, etc.,

H. ROBBINS.

FORTHCOMING EVENTS.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS.

The next meeting of the Society will be held on Wednesday, November 3, at the Chemical Society's Rooms, Burlington House, Piccadilly, W.1., at 8 p.m. The following papers will be read :—

"Investigations into the Analytical Chemistry of Tantalum, Niobium, and their Mineral Associates. VI. The Precipitation of the Earth Acids by Sodium Compounds." By W. R. Schoeller, Ph.D., and C. Jahn.

"A Simple Method of Testing for the Presence of Sulphites in Foods." By A. E. Parkes, F.I.C.

"A Critical Review of the Methods of Analysing Waters, Sewages and Effluents, with Suggestions for their Improvement." By J. W. Haigh Johnson, M.Sc., F.I.C.

One Candidate for admission to the Society will be balloted for.

PHYSICAL SOCIETY OF LONDON.

The next meeting of the Society will be held on Friday, October 22, 1926, at 5 p.m., at the Imperial College of Science, Imperial Institute Road, South Kensington, S.W.7.

A demonstration of Selenium Cells will be given by Professor Thirring, Professor of Theoretical Physics in the University of Vienna. The following papers will be read :

"The Corrosion Products and Mechanical Properties of Certain Light Aluminium Alloys, as affected by Atmospheric Exposure." By Professor Ernest Wilson.

"The Distribution of Intensity in a Positive Ray Spectral Line (Part II.)." By M. C. Johnson, M.A., M.Sc.

ROYAL INSTITUTION.

Tuesdays, November 2, 9 and 16, at 5.15 p.m. : "The Acoustics of Public Buildings." By G. W. C. Kaye ,O.B.E., M.A., D.Sc. Synopsis of first Lecture, November 2 :— Introduction. Suitable generators of sound for experimental purposes. Electrical loud speakers. Various types of microphones for intensity measurements. The analysis of sound. The sensitivity and range of the ear. The acoustic characteristics of speech and music. Accoustical demands in an auditorium. Loudness and seating arrangements. Echoes and general shape.

Thursdays, November 4 and 11, at 5.15 p.m. : "Exploration and Problems of Antartica." By Sir Edgeworth David, K.B.E., C.M.G., LL.D., F.R.S. Synopsis of first Lecture, November 4 :—Motives for Antarctic Exploration—

(a) Commercial : (i) Whaling ; (ii) Sealing ; (iii) Discovery of economic minerals.

b) Adventure—the quest of the unknown.

(c) Scientific : (i) Meteorological—Antarctica a giant refrigerator and the home of the blizzard ; (ii) Geographical ; (iii) Physical—Aurora Australis, Magnetism, Gravity, etc. ; (iv) Geological ; (v) Biological and Palæontological.

2. Brief summary of antarctic Explorations, with special reference to the Scott, Shackleton and Mawson expeditions.

3. The Problems—

(a) Geographical : (i) What becomes of the Antarctic Andean chain after it leaves Graham Land trending southwards, and how is it related to the Antarctic "horst"? (ii) Is Weddell Sea continuous with Ross Sea?, etc.

(b) Physiographical—The Ice Problem : (i) Various local types of ice ; (ii) The area, thickness and volume of the ice-cap—Lord Kelvin's predictions verified—Control of sea-level by Antarctic ice-cap ; (iii) Possible causes of the shrinkage of the Antarctic ice-cap.

ROYAL SOCIETY OF ARTS.

Tuesday, November 2, at 4.30 p.m.—(Dominions and Colonies Section.) — Sir Stanley Bois, "The Importance of Rubber in the Economic and Social Progress of the World." Sir Edward Rosling will preside.

Wednesday, November 10, at 8 p.m.—(Opening Meeting.) — Sir Thomas H. Holland, K.C.S.I., K.C.I.E., D.Sc., F.R.S., Rector of the Imperial College of Science and Technology, Chairman of the Council of the Society, "International Interests in Raw Materials."

INSTITUTION OF ELECTRICAL ENGINEERS.

Thursday, November 4.—J. R. Beard, M.Sc., and T. G. N. Haldane, B.A., "The Designs of City Distribution Systems, and the Problems of Standardisation."

Wireless Section Meeting.—Wednesday, November 3, at 6 p.m.—Inaugural Address of the Chairman. Professor C. L. Fortescue, O.B.E., M.A.

North Wales Centre (The University, Liverpool, Laboratories of Applied Electricity).—Monday, November 8, at 7 p.m.—L. C. Grant, "High-Power Fusible Cutouts."

North-Eastern Centre, Armstrong College, Newcastle-on-Tyne.—Monday, November 8, at 7 p.m.—S. Mavar, "The Application of Machinery at the Coal Face"; also L. Miller, "The Design of Storage-Battery Locomotives for use in Coal Mines"; also R. Nelson, "Electricity in Mines."

Scottish Centre, Royal Technical College.—Tuesday, November 9, at 7.30 p.m.—W. L. Winning, Chairman's Address.

North-Western Centre, Engineers' Club, 17, Albert Square, Manchester.—Tuesday, November 2, at 7 p.m.—W. J. Medlyn, Chairman's Address, followed by a smoking concert.

MINERALOGICAL SOCIETY.

Tuesday, November 2, at 5.30.—Anniversary Meeting. Dr. L. J. Spencer, with a chemical analysis by E. D. Mountain: "Schultenite, a New Mineral, from South-West Africa." Dr. L. J. Spencer, with a chemical analysis by E. D. Mountain: "Aramayoite, a new mineral, from Bolivia." Miss Kathleen Yardley: "X-ray Examination of Aramayoite." Miss Kathleen Yardley: "The Strncture of Baddeleyite and of Prepared Zirconia." W. Binks: "The Crystaliine Structure of Zircon."

FLUORSPAR AND CRYOLITE IN THE U.S.A.

By HUBERT W. DAVIS (Bureau of Mines).

FLUORSPAR.

Fluorspar, or fluorite, is a non-metallic crystalline mineral that usualy occurs in glassy transparent cubes or cleavable masses less commonly it is granular or fibrous in structure, and occasionally is banded. Fluorspar has a specific gravity of 3.2, is brittle, has a hardness of 4, and can easily be scratched with a knife. Chemically it consists of calcium and fluorine in the proportion of 51.1 to 48.9. In color fluorspar ranges, according to purity, from a clear colorless, or slightly bluish, glasslike substance through various brilliant hues, of which purple and green are most common; much of it is white and opaque.

FLUORSPAR SHIPPED.

Notwithstanding the record production of steel in 1925, the shipment of fluorspar to steel plants were 12 per cent. less than in 1924. There was also a decrease of 12 per cent. in shipments of fluorspar to foundries. Of the higher grades of flourspar, the shipments to manufacturers of glass and hydrofluoric acid were, respectively, 11 and 41 per cent. more than in 1924, but the shipments for use in enamel and sanitary ware were 7 per cent. smaller.

The total shipments of fluorspar from domestic mines in 1925 amounted to 113,669 short tons, valued at $2,052,342, a decrease of 9 per cent. in quantity and 16 per cent. in total value as compared with 1924. The general average value per ton f.o.b. mines or shipping points for all grades in 1925 was $18.06, a decrease of $1.55 from the average in 1924. New Mexico was the only State to show an increase of shipments in 1925.

CRYOLITE.

Cryolite occurs in commercial quantities and is mined only in Greenland, at Ivigtut. Formerly two-thirds of the product was sold to the Pennsylvania Salt Co., and the other third went to Copenhagen, but at present these relative proportions are reversed. Of the cryolite shipped to the United States the greater part is now used as a flux in the metallurgy of aluminium and for making opaque glass. In aluminium metallurgy in this country the mineral is being supplanted by an artificial cryolite.

An article on the cryolite mine at Ivigtut has recently been published. It discusses the discovery, exploitation, and mining of cryolite and describes the geology and mineralogy of the deposit.

NOTICES OF BOOKS.

Practical Colloid Chemistry. By WOLFGANG OSTWALD, Professor of the University of Leipzig, with the collaboration of DR. P. WOLFSKI, AND DR. A. KAHN. Translated by I. NEWTON KUGELMASS, M.D., Ph.D., Sc.D., Yale University School of Medicine, AND THEODORE K. CLEVELAND, Ph.D. Pp. XVI. + 200, with 22 illustrations. Price 7s. 6d. net. London: Methuen & Co., Ltd., 36, Essex Street, W.C.2.

Evidently this book has met with considerable approval, seeing that in two years three editions have come from the press, the present being the fourth edition. It is satisfactory to note that the present issue has been revised, so as to bring its pages up-to-date and in harmony with recent progress in Colloid Chemistry. This will render the work valuable in a supplementary sense to those who may have secured a copy of one of the previous editions.

Volume Alterations on and in Solutions. By F. L. TEED, D.Sc. (London). Pp. X. + 62. Cr. 8vo. Price 3s. 6d. net. London: H. H. Lewis & Co., Ltd., 28, Gower Place, W.C.1.

This handsome and useful book is formed of three sections:—

1. A method for ascertaining the volumes of the constituents of a mixture, after mixture.

2. A method for ascertaining the rate of expansion by heat of the constituents of a mixture, after mixture.

3. A suggested working hypothesis to explain certain abnormal specific heats of alcohol mixtures.

The author does not pledge himself to the accuracy of the results obtained by his methods; and very wisely so, under the circumstances; but with equal justice infers that until more accurate results are shewn by other means, they hold the field, and onght to prove serviceable to investigators, probably not so much for what they actually demonstrate as for what they suggest.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

25,106—British Dyestuffs Corporation, Ltd.—Manufacture of vat dyes. October 8th.

24,699.—I. G. Farbenindustrie Akt.-Ges.—Activation of carbon. October 5th.

24,914.—Coley, H. E.—Manufacture of barium sulphide. October 7th.

24,915.—Coley, H. E.—Reduction of carbonates, etc. October 7th.

24,916.—Coley, H. E.—Reduction of sulphates. October 7th.

Specification Published.

258,950.—British Cyanides Co., Ltd., and Rossiter, E. C.—Process for the manufacture of articles from synthetic resins.

258,973.—Farbenfabriken vorm F. Bayer & Co.—Manufacture of new complex alkali or alkaline earth antimony compounds.

258,974.—Kudob, K.—Catalytic process for producing concentrated and fuming sulphuric acid.

259,102. Jahl, A.—Process for the production of "blanc fixe" from barium sulphide.

250,555.—Chemische Fabrik Auf Actien (Vorm. E. Schering).—Process for the manufacture of esters of isoborneols and borneols.

256,734.—Titanium sulphate and oxide.—MacKay, P. A., Adelaide House, King William Street, London.

A titanium ore such as ilmenite, in the form of powder containing its natural moisture or having some moisture intentionally added, is treated with oleum, when an exothermic reaction takes places and goes to a conclusion without the application of heat. From the product titanium oxide may be obtained by dilution with water.

Printed Copies of the full Published Specification may be obtained from the Patent Office, 25 ,Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

Abstract Published.

256,394.—Synthetic resins.—Regal, A., 11, Fiscroval, Brno, Czechoslovakia.

Phenol-aldehyde condensation products.—Phenol is condensed with formaldehyde in the presence of products formed by allowing formaldehyde to act on an aromatic amino compound, one or both of the hydrogen atoms of the amino group of which are replaced by organic radicals, such as dimethyl- or diethylaniline. In an example, formaldehyde is heated with a small quantity of dimethylaniline, some hexamethylenetetramine and paraformaldehyde are then added, and the mixture is further heated to form tetramethyl-*p*-diaminodiphenylmethane. On cooling, the mass is heated with phenol to produce a "resol" which, on further heating, is converted into a "resit." Inert filling materials may be added at any stage of the process.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

GLOWOL.

470,901.—Chemical substances used in manufactuers. — John Houston, 157 and 208, Crumlin Road, Belfast. October 13th.

BESCONDI.

473,012.—Chemical substances used for agricultural, horticultural, veterinary and sanitary purposes.—Chapman & Son (Grimsby), Ltd., 235 to 237, Cleethorpes Rd., Grimsby, Lincolnshire. October 13th.

NOVIFORM.

471,319.—Chemical substances prepared for use in medicine and pharmacy, but not including any goods of a like kind to nerve medicines.—Chemische Fabrik Von Heyden Aktiengesellschaft, 57, Leipzigerstrasse, Radebeul, near Dresden. October 13th.

REYNOLINE.

471,252.—Chemical substances prepared for use in medicine and pharmacy.—Reynolds Sons & Co., Ltd., 55, Charterhouse Street, Smithfields, London, E.C.1. October 13th.

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RESTRICTIONS ON EUROPEAN TRADE.

A PLEA FOR THEIR REMOVAL.

A document signed by eminent bankers from many countries has been issued. They point out that it is difficult to view without dismay the extent to which tariff barriers, special licences and prohibitions since the war have been allowed to interfere with international trade and to prevent it from flowing in its natural channels. At no period in recent history has freedom from such restrictions been more needed to enable traders to adapt themselves to new and difficult conditions.

The break-up of great political units in Europe dealt a heavy blow to international trade. Across large areas, in which the inhabitants had been allowed to exchange their products freely, a number of new frontiers were erected and jealously guarded by customs barriers. Old markets disappeared. Racial animosities were permitted to divide communities whose interests were inseparably connected.

To mark and defend these new frontiers in Europe, licences, tariffs and prohibitions were imposed, with results which experience shows already to have been unfortunate for all concerned. One state lost its supplies of cheap food, another its supplies of cheap manufactures. Industries suffered for want of coal, factories for want of raw materials. Behind the customs barriers new local industries were started, with no real economic foundation, which could only be kept alive in the face of competition by raising the barriers higher still. Railway rates, dictated by political considerations, have made transit and freights difficult and costly. Prices have risen, artificial dearness has been created. Production as a whole has been diminished. Credit has contracted and currencies have depreciated. Too many states, in pursuit of false ideals of national interest, have imperilled their own welfare and lost sight of the common interests of the world, by basing their commercial relations on the economic folly which treats all trading as a form of war.

Happily there are signs that opinion in all countries is awaking at last to the dangers ahead. The League of Nations and the International Chamber of Commerce have been labouring to reduce to a minimum all formalities, prohibitions and restrictions, to remove inequalities of treatment in other matters than tariffs, to facilitate the transport of passengers and goods. In some countries powerful voices are pleading for the suspension of tariffs altogether. Others have suggested the conclusiou for long periods of commercial agreements embodying in every case the most-favoured-nation clause. Some States have recognised in recent treaties the necessity of freeing trade from the restrictions which depress it. And experience is slowly teaching others that the breaking-down of the economic barriers between them may prove the surest remedy for the stagnation which exists. On the valuable political results which might flow from such a policy, from the substitution of good-will for ill-will, of co-operation for exclusiveness, we will not dwell. But we wish to place on record our conviction that the establishment of economic freedom is the best hope of restoring the commerce and the credit of the world.

REACTION REGIONS.

General Remarks II.

By W. P. Jorissen.

In a previous paper (*Chem. News*, No. 3183, March 5, 1926, CXXXII., 150), I treated the forms of the reaction regions found by reasoning, and I reproduced some of the principal reaction regions found by experiment. Now, several investigators (especially White, *J. Chem. Soc.*, 1919, CXV., 1462; 1922, CXXI., 2561; 1925, CXXVII., 48) have made experiments on the explosion limits of mixtures of two inflammable gases or vapours. Their principal aim was to study the deviations from the formula of Le Chatelier,

$$\frac{n}{N} + \frac{n'}{N'} = 1,$$

N and N' being the lower limits of inflammability of the two combustible gases or vapours, n and n' the volumes of these gases in the mixture which, with air, gives an inflammable mixture.

Last year I drew attention (*Rec. trav. chim.*, 1925, XLIV., 1041), to the fact that if we consider n and n' as variables, the formula is the equation of a straight line, N and N' being the intercepts on the axes.

Thus, representing the limiting mixtures observed by White and others by points in a plane, these points will be situated in a straight line, if the mixtures obey the formula of Le Chatelier.

In many cases, however, the experimental results do not agree with this formula; then curved lines will be obtained. The curves of the lower and upper limits enclose the explosion *region*. See the figures in my paper *Rec. trav. chim.*, 1925, XLIV., 1042, 1043 and also the figures VIII., IX. (AC and BD)and XI. in my previous communication in *Chem. News*, 1926, CXXXII., 150-152).

Using the figures X. and XI. we are able to predict how the explosion region hydrogen-ammonia-oxygen will change on gradually replacing oxygen by nitrogen.

If we measure the nitrogen vertically upwards from figure XI., we shall get a space figure representing the explosion region hydrogen-ammonia-oxygen-nitrogen.

Such a space figure I have investigated experimentally with Mr. B. L. Ongkiehong for the system ethyl bromide-ammonia-oxygen-nitrogen. (*Rec. trav. chim.*, 1926, XLV., 400). The difference between this system and the former one is that ethyl bromide and ammonia both have, under the circumstances of our experiments, explosion limits in oxygen but not in air.

The explosion space is represented in outline in figure I. The figures II. and III., represent the explosion regions $NH_3 - O_2 - N_2$ (in figure I. : TSHEJP), and $C_2H_5Br - O_2 - N_2$ (in figure I. : RMGBACFLQ).

Figure IV. shows how the explosion region $C_2H_5Br - NH_3 - O_2$ is reduced by adding nitrogen. A metastable part is found on the right side of line VQ. There only supersaturated vapour could have been used. Therefore the explosion space (Fig. I.), also contains a metastable part UVLKQW.

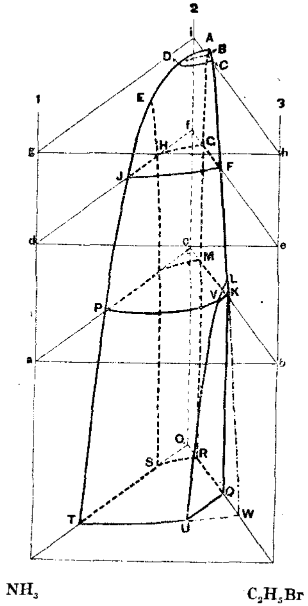

Fig. I.
Explosion Space $C_2H_5Br-NH_3-O_2-N_2$.

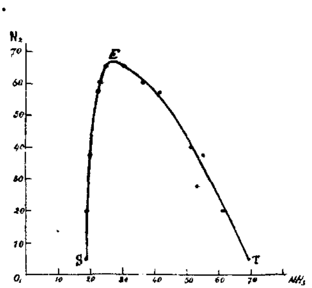

Fig. II.
Explosion Region NH_3-O_2-N_2.

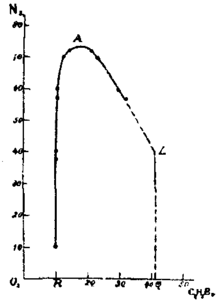

Fig. III.
Explosion Region C_2H_5Br-O_2-N_2

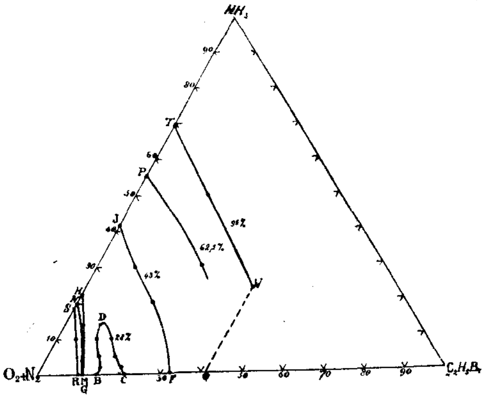

Fig. IV.
Explosion Regions of C_2H_5Br and NH_3 mixed with oxygen-nitrogen mixtures containing 95, 62.5, 43 and 28% of oxygen.

The study of the explosion space of methane, with air and two " inhibitors " (one of them measured vertically upwards as in figure I.) promises to give practical results with regard to the prevention of mine explosions.

The use of a mixture of nitrous oxide, ether vapour and oxygen as an anæsthetic for surgical operations has raised the question as to which mixtures would explode if brought into contact with a spark or heated wire.

For this reason we have determined (see Jorissen and Ongkiehong, *Rec. trav. chim.*, 1926, XLV., 633), the explosion regions N_2O - $(C_2H_5)_2O$ - O_2 and N_2O - $(C_2H_5)_2O$ - air. They are represented in figure V. : ADCB is the explosion region of nitrous oxide with ether vapour and oxygen. ADCE is the explosion region of nitrous oxide,

ether vapour and air. On adding air to the mixture with oxygen the line CB, revolving round C, moves to the left and finally coincides with the line CE.

That mixtures of nitrous oxide and ether vapour may be explosive, was to be expected, as explosions in mixtures of that endothermic gas with hydrogen, ammonia, carbon monoxide, cyanogen, phosphine and hydrogen sulphide have been observed.

When the spark is strong enough to start in nitrous oxide (without ether vapour) a reaction which propagates itself, the line AD will revolve round A and cut the left side of the triangle.

We have made many experiments with chloroform-nitrous oxide-oxygen mixtures. But none of these were found to be explosive. This system appears to have no explosion region at the ordinary temperature. (*Rec. trav. chim.*, 1926, XLV., 636).

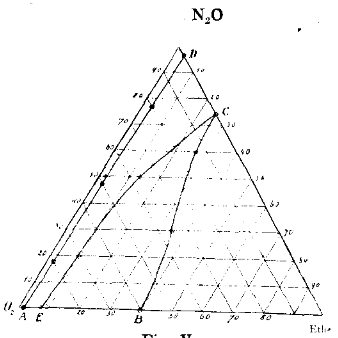

Fig. V.
Explosion Regions N_2O-ether-O_2 and N_2O ether-air.

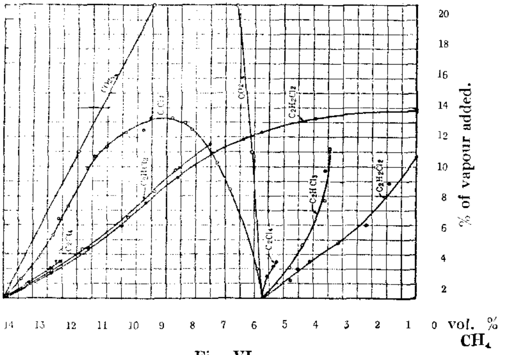

Fig. VI.
Explosion Regions CH_4-air-CCl_4, CH_4-air-C_2HCl_3, CH_4-air-$C_2H_2Cl_2$, CH_4-air-C_2Cl_4 (Coward and Jones).

In the September number of *Industrial and Engineering Chemistry* (pp. 970-974), H. F. Coward and G. W. Jones have published their experiments on the extinction of methane-air flames by some chlorinated hydrocarbons. The results with carbon tetrachloride, trichloroethylene, dichloroethylene and tetrachloroethylene are represented in figure VI. It is pleasant to notice that the explosion regions CH_4-air-CCl_4, CH_4-air-C_2HCl_3 and CH_4-air-$C_2H_2Cl_2$ are examples of the three principal types of reaction regions (explosion regions) described by me in January of this year (*Chem. Weekblad*, 1926, XXIII., 79; see also, *Chem. News*, No. 3438, March 5, 1926, CXXXII., 150).

With carbon monoxide and hydrogen as inflammable gases, explosion regions had been found already by experiment, using the same chloro derivatives (Jorissen, Langen van der Valk, Onkiebong, *Rec trav. chim.* 1925, XLIV., 810, 814). See figures VII., and VIII.

The explosion region CO-air-CCl_4 is very small (*Chem. News*, 1926, CXXXII, 151); that of CO, air, $C_2H_2Cl_2$ resembles that of CH_4, air, $C_2H_2Cl_2$; that of H_2, air, C_2HCl_3 resembles that of CH_4, air C_2HCl_3.

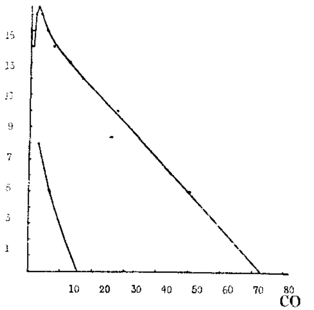

Fig. VII.

Explosion Region CO-air-$C_2H_2Cl_2$.

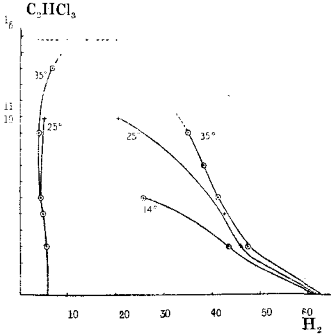

Fig. VIII.

Explosion Region H_2-air-C_2HCl_3.

The same three types found by Coward and Jones have been observed also with CO-air-$CHCl_3$, CO-air-CH_2Cl_2 and CO-air-CH_3Cl mixtures (Jorissen and Langen van der Valk, *Chem. Weekblad*, 1926, XXIII., 80; *Chem. News*, 1926, CXXXII., 151. See there, figure IX.).

Using methane as inflammable gas we had made some experiments with the chloro derivatives carbon tetrachloride, perchloroethylene (tetrachloroethylene), trichloroethylene, dichloroethylene, tetrachloroethane and pentachloroethane (Jorissen, Velisek, Meuwissen, *Chem. Weekblad*, 1921, XVIII., 636; *Rec. trav. chim.*, 1924, XLIII., 80, 591; 1925, XLIV., 132). These observations were only preliminary ones as no explosion *regions* were determined. Those of Velisek have been made with impure methane (analysis see *Rec. trav. chim.*, 1924, XLIII., 593). Therefore they may not be compared with the experiments of Coward and Jones.

There is no difficulty in explaining the differences between their other experiments and ours (with Mr. Meuwissen).

First of all the experimental procedure was quite different. Coward and Jones used a glass tube 5 feet long, 2 inches internal diameter, ignition being effected by drawing the flame of a small spirit lamp across the open end of the tube*.) We used tubes, about 1.5 cm. internal diameter, in which the mixture was fired by *one* small spark near the top of the tube.

Then the large influence of the mode of propagation must be mentioned. The curves representing A. G. White's results (Jorissen, *Rec. trav. chim.*, 1925, XVIV., 1043), on the explosion limits of hydrogen-ammonia-air mixtures have shown that the explosion region for upward propagation extends itself to the ammonia axis, but not that for downward propagation.

In our experiments, downward propagation always took place, in those of Coward and Jones ,always upward propagation. In the latter case the explosion regions will be larger; the effect of CCl_4, etc., will be found to be smaller.

Finally, the chloroderivatives used had a different purity; see the boiling points of our chemicals (*Rec. trav. chim.*, 1925, XLIV., 133, 134), and of those used by Coward and Jones (their paper, p. 972).

Mentioning the different results which we observed using different burettes, Coward and Jones say :

* Only in some experiments with tetrachloroethylene they used a tube which somewhat resembled ours, but their spark was much stronger (gap 5 mm.), and they do not say whether they passed only *one* spark, as we do.

"This inconsistency proves that Jorissen was not observing whether or not his mixtures were capable of propagating flame per se. His apparatus is not satisfactory to insure certain ignition and also to give the resultant flame a long enough 'run' to enable observers to judge whether it is self-propagating when it has lost the initial impulse due to the source of ignition.'

Our answer is: In all our experiments we have determined the limit between reaction (some propagation) and no reaction (no propagation at all). When we investigated a certain reaction region (explosion region), we always took care to do so under the same conditions (the same tube, spark, substances, etc.). Thus the reaction regions CO-$CHCl_3$-air, CO-CH_2Cl_2-air and CO-CH_3Cl-air (mentioned above), which we compared with each other, have been determined under the same circumstances.

We have to answer still one remark. Coward and Jones say:

"Jorissen's failure to appreciate the experimental requisites of this type of work is further illustrated by the following quotation from his first paper:—

From Bunsen's observations on the explosibility of hydrogen-oxygen mixtures, a lower explosion limit of about 6.1 vol. per cent. may be calculated. When we compare this limit with that for hydrogen air mixtures as determined by J. Roszkowski, *viz.*: 9.5 vol. per cent., we note the considerable influence of nitrogen. For the proportion between the concentrations of hydrogen and oxygen has been increased from $\frac{6.1}{93.9}$ to $\frac{9.50}{19}$.

"The comparison between Bunsen's observations on hydrogen-oxygen mixtures with Roszkowski's on hydrogen-air mixtures involves other variables, the explosion vessel and the means of ignition. It is unnecessary so to complicate matters for Roszkowski himself made a direct comparison between the lower limit of hydrogen in air and in oxygen, finding them to be 9.5 and 9.7 per cent. respectively. Hence in comparable experiments the influence of nitrogen in this example is inconsiderable."

I suppose that Coward and Jones did not see that I was comparing *proportions*. My reasoning remains the same, whether I compare the proportions $\frac{6.1}{93.9}$ and $\frac{9.5}{19}$, or $\frac{9.7}{90.3}$ and $\frac{9.5}{19}$. In both cases the increase is considerable.

As regards the *reaction regions of solid mixtures* we have been able to study (with Mr. Ongkiehong, *Rec. trav. chim.*, 1926, XLV., 540), some examples which show the same three types of reaction regions as those mentioned above. They are drawn in figures IX., X., and XI.

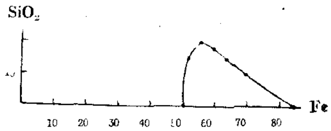

Fig. IX.
Reaction Region Fe-SiO_2-S.

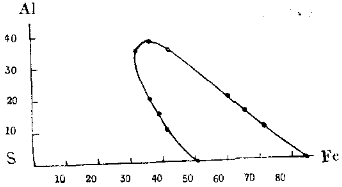

Fig. X.
Reaction Region Fe-Al-S.

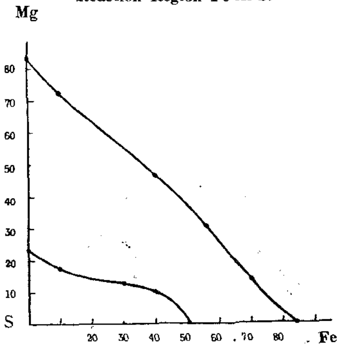

Fig. XI.
Reaction Region Fe-Mg-S.

A huge field of research opens itself before us. In the first place we can mention the study of those mixtures which are called "thermites." But next to them in importance are those in which silicon is the reducing agent. Then we have the domain of explosives. There the determination of the reaction regions and the influence of stabilising substances on these will be valuable; also, of course, the knowledge of the reaction velocity in different parts of the regions.

These and other examples are to be found in our working-programme.

Inorganic Chemistry Laboratory,
The University,
Leiden, Holland.
September, 1926.

General Notes.

HOW THE DISTANCES OF STARS ARE DETERMINED.

DOMINION ASTROPHYSICAL OBSERVATORY AT VICTORIA, B.C., CO-OPERATES WITH OTHER OBSERVATORIES IN THIS WORK.

That the stars differ in their *apparent* brightness is self-evident. A thoughtful person might surmise that this is due either to a difference in their light-giving powers or to their being situated at different distances from us. As a matter of fact both are contributory causes and it is only when we know the distance of a particular star that we can have an idea of its real luminosity.

The distances of the nearer stars are determined by a process of triangulation somewhat similar to that which the surveyor uses to obtain the distance of an inaccessible mountain peak. Naturally, the base line must be enormously longer than any used upon the earth and the one that best serves the purpose is the diameter of the earth's orbit about the sun. The small relative shiftings in the positions of the stars as photographed from each end of this 186,000,000-mile base give us data from which to compute their distances.

The Canadian Department of the Interior says that through the co-operation of half a dozen observatories in Europe and America the distances of several hundred of the nearer stars had been determined by this triangulation method before the war and this number has been materially increased since. Knowing, then, their distances and their *apparent* brightnesses, their *real* or absolute luminosities are easily computed. It has been found that there is a great disparity amongst them, probably a millionfold being not an extreme ratio. Our own star, the sun, while 100 times brighter than some that are reached by our telescopes, is nevertheless outshone 10,000-fold by others which are designated "giant" stars.

An examintion of the spectra or analysed light of these stars of different real luminosities revealed peculiarities by which it was possible to reverse the process and predict the corresponding real brightnesses. That is to say, if we were to secure the spectrum of a star the distance and real brightness of which was unknown we could, from these tell-tale peculiarities, determine the absolute brightness of that particular star. It is then a simple calculation to find out how far away a star of such known brightness must be to appear of the brightness we see it in the sky.

It is in the search for these tell-tale peculiarities in the spectrum that the Dominion Astrophysical Observatory, Department of the Interior, at Victoria, British Columbia, has taken a leading part among the observatories of the world. Many new lines in the spectrum have been found which are specially sensitive in this regard, and the added material has greatly improved the accuracy of the method. A list of over 1,100 stars the distances of which have been thus determined has been issued as a publication of the observatory.

The distances cannot be quoted in miles but a popular standard of measurement is the "light-year," which is simply the distance light will travel in a year at its rate of 186,000 miles per second. At this rate light reaches us from the sun in eight and one-third minutes, yet the distance of the nearest of the fixed stars is such that light requires four and one-half years to traverse the distance and consequently we say it is 4½ light-years distant. Another relatively Sirius, the bright star of the winter skies, distant 9 light-years. This investigation Arcturus and Polaris, stars used a great deal by surveyors, at distances of 41 and 466 light-years respectively, whilst the double star *Beta Cygni*, at the foot of the Northern Cross, is nearly 1,100 light-years distant. Moreover it is found that the stars do not extend to equal distances in all directions; they extend to much greater distances in the direction of the Milky Way than they do at

right angles to that plane. The stellar universe is thus not spherical but rather disc-like in form with the long diameter about ten times the shorter.

The main value of such researches is in this determination of the form and structure of the universe—the problem towards the solution of which practically all astronomical investigation tends. When results for the distances of the stars had to be based upon triangulation methods alone we could reach out to a limited distance only. The base line of 186,000,000 miles, enormous as it is relative to earthly standards, is nevertheless, inadequate for all but the nearer stars and necessity drove astronomers to seek some other method of attacking the problem. The newer method adopted at and enlarged upon at Victoria has the decided advantage that it is usable no matter how infinitely remote the star may be, provided only it is bright enough for its spectrum to be secured. The great light gathering power of modern telescopes makes it possible to secure the spectra of extremely faint stars.

A by-product of the work has been the aid rendered the physicist in his study of the atom. When the astronomer found that certain spectral lines were particularly intense in intrinsically bright stars the physicist was led to seek the reason for the same and the facts marshalled by the astronomer from the high temperature stars have aided materially in elucidating the structure of the atom.

INTERNATIONAL CONFERENCE ON BITUMINOUS COAL.

CARNEGIE INSTITUTE OF TECHNOLOGY.

The Carnegie Institute of Technology announces a conference on Bituminous Coal to be held at Pittsburgh, November 15 to 18, 1926.

A number of professors and others from various parts of the United States and Europe are to attend and speak.

The purpose of the meeting is to consider new uses for bituminous coal and to present the results of recent investigations of coal that are concerned with improved methods of utilisation and combustion.

A number of distinguished European scientists will take part, as well as some of the best-known American fuel technologists and engineers. The programme will include the discussion of the manufacture of substitutes for gasoline from coal, complete gasification of coal, high temperature distillation, low temperature distillation, coal tar products, power, smokeless fuel, fertilisers, etc.

The representatives from England, and the subjects of their address at the congress, it is announced, are: Dr. C. H. Lander, Director of Fuel Research of the Department of Industrial Research, "The Present Status of Low Temperature Distillation of Coal in England"; Dr. R. Lessing, Consulting Engineer, London, "Coal and Its Mineral Matter"; Geoffrey M. Gill, Consulting Engineer, London, "English Developments in Carbonisation of Coal in Gas Works"; and Harold Nielsen, Sensible Heat Distillation, Ltd., London, "The L. and N. Process."

NEW TESTING LABORATORY AT CINCINNATI.

Announcement is made of the formation of Robert J. Anderson, Inc., to operate as a commercial testing laboratory, specialising in metals and alloys.

The new laboratory, which is situated at 2416-38 Beekman Street, Cincinuati, Ohio, is fully equipped for chemical analysis, mechanical testing, metallography, heat treatment, and radiography.

The laboratory is staffed with a corps of qualified chemists and metallurgists under the direction of Dr. Robert J. Anderson, the well-known metallurgical engineer and expert on aluminium.

Officers of the company are: Dr. Robert J. Anderson, president; H. J. Hater, treasurer; and R. T. Mesker, secretary. These, with John Eckerle and E. F. Eckerle, form the incorporators and directors. Further details will be announced later.

PROCEEDINGS OF THE THIRTEENTH INDIAN SCIENCE CONGRESS. SECTION OF CHEMISTRY.

President—PROF. B. B. DEY, D.Sc., F.I.C.

PRESIDENTIAL ADDRESS.

January, 1926.

"In proportion as I appreciate the honour that Executive Committee of the Science Congress has done me by inviting me to preside over the deliberations of the Chemistry section this year, a sense of the responsibilities of the position appears to

increase until I scarcely feel competent to fulfil it adequately. The task it involves is not easy at any time, and is becoming increasingly difficult with the growing literature in our Science. The mass of exact and detailed experimental material that has been laboriously collected and recorded in Organic Chemistry during the last hundred years has turned us all into specialists: each one of us has been ultimately forced to settle down and cultivate only a minute patch of this vast field. Whilst reflecting, therefore, during the last few weeks as to what should form the subject of the customary address this year, I felt that instead of treating you with the details of a rather specialised branch of chemistry that has been immediately engaging my attention, however great my personal predilection for it, I should make this occasion an opportunity for laying before you some reflections on a subject in which developments of fundamental importance have been taking place at the present day—a subject which is the direct outcome of the co-operation of the Chemist and the Biologist, and whose fullest development is perhaps conterminous with the vast realm of Life itself. I am fully conscious, however, that in dealing with this subject, I am entering a field in which I play the part of a fascinated on-looker rather than that of an active member of the vast army of workers who have already invaded it.

A century has nearly passed since Wöhler, by his synthesis of urea in the laboratory, deduced the far-reaching generalisation that the constituents of living organisms are not endowed through the operation of an undefinible "vital force," with properties peculiar to themselves, but are capable of decompositions and syntheses governed by just the same laws as are found to apply in the inanimate world. The brilliant researches of Berthelot, Kolbé, Strecker and others, which closely followed, led to the reproduction of many other vital products which had till then been considered to lie solely within the range of Nature's powers of elaboration. These discoveries gave a violent shock to the so-called mysteries of Vitalism. To borrow a military expression, these conquests of the chemist might be compared to the sudden raising of the portcullis of a castle—the hitherto impregnable fortress of Nature (—) and the occupation of numerous posts of vantage in quick succession. This was the first stage in that remarkable progress in organic chemistry to which perhaps there has been no parallel in the history of any other science—a period in which chemists were engaged in the separation, identification and examination of natural products or of substances derived from them by familiar and often long known processes. Chevreul's researches on the fatty bodies, Liebig and Wöhler's investigation of the oil of bitter almonds, and its derivatives, those of Berthelot, Williamson, Kolbé and others on the alcohols, ethers, etc., as well as the separation of essential oils and natural alkaloids, may serve as illustrations of the kind of work referred to. The comparison and co-ordination of the results so obtained led in later periods to the recognition of what may be called natural families of chemical substances, gradually ushering in those eras of new compounds, of the problems of their constitution and their application in industries, which have continued to the present day. Indeed, a retrospective survey of these successive stages would fully warrant the belief that the modern edifice of organic chemistry owed its origin and received its inspiration from the desire of the chemist to reproduce in the laboratory such substances as had been built up by the living plant or animal. The extent of the success that has attended his efforts in this field may be gauged from a comparison of those early attempt at reproducing such simple bodies as urea, alcohol and acetic acid with the modern synthesis of a dodecapeptide closely resembling the natural albumens, or of the other complex products of Nature such as a vegetable alkaloid or an anthocyanin pigment.

It must be confessed, however, that these triumphs of the laboratory have been achieved by the chemist by methods which are seldom identical with or even equivalent to those employed by Nature. The history of nineteenth century organic chemistry unfolds a narrative of a marvellous development in carbon chain and cycle syntheses, but does not carry us very far in the way of advancing what must have been the real issue with the founders of our science—*i.e.*, the reproduction of vital products with the object of understanding, and ultimately copying Nature's processes for elaborating these.

The causes that led to this digression are various and need not be detailed here. I would only refer to what was probably one of the deciding factors in creating this diversion—the discovery of coal tar and all its wealth of benzenoid substances. The question as to what might have been the

course of development of our science had this discovery not been made, and we were *left to the resources of Hofmann in his early* days in the Royal School of Science, for preparing a few grams of aniline at the end of a full day's labour, has often appealed to me as offering an interesting subject for speculation. The competition and struggle for the commercial exploitation of every new discovery in our science which followed *the separation of even the first few fractions* of coal tar, left little leisure, even if there was inclination, to the large majority of the workers to inquire into the methods of the living machine. Besides, such an inquiry was generally believed to be of purely academic interest and not of any practical benefit to humanity. And yet when we *reflect for a moment, and consider the ex*tent to which we depend for our very existence on the synthetic preparations of the laboratory and on those given us by Nature, the endeavour to appreciate how and why certain compounds are produced in plants and animals can scarcely be dismissed as merely of scholastic value. Indeed it is not *inconceivable that* the processes occurring there, when understood more clearly, will be found to be not only simpler but more efficient than our present day laboratory methods. It may perhaps be objected that it is only expressing a pious hope and nothing more, there being so little experimental justification for it at the present *moment. Even if this be so, it need scarcely* be pointed out that our attempts at acquiring greater mastery over the secrets of biochemical processes cannot fail to bring us into possession of such definite information regarding the evolution and functions of the diverse compounds found in the living organism as will lead to the discovery of fundamental principles and profoundly influence such important branches of knowledge as Agriculture and Medicine. The discovery of insulin, probably a protein enzyme complex, and its functions in relation to diabetes mellitus which is the result of a steady advance along already foreshadowed lines of investigation, may be cited as a significant illustration of this.

I have referred to the discovery of coal-tar and its industrial possibilities as one of the disturbing events of the last century, which drew the chemist away from the problems of vital chemistry, but there were other factors which contributed in no small measure to the same result. One of the most important of these was the almost morbid antipathy shown by the orthodox chemist to the investigation of anything that was not characterised by a crystalline structure. Our laboratory experience of a vital product generally commenced at the point when out of the muck of the enveloping and inter*penetrating gelatinous mixture, usually met* with in Nature, we had succeeded in dragging some one definite crystalline individual and having it free from what was regarded as defiling impurity, we proceeded to analyse and ultimately synthesise it if possible. Yet time has forced the lesson upon us that there is a vast and a most im*portant tract of the material world not* characterised by any of the typical crystalline structures but which falls under the category of the so-called "mess"—the colloids. It is strange that our appreciation of its importance should have come so late, considering the fact that all living things with their infinite manifestations of changes *are steeped in colloids.* The plastic elements of the plant and animal body are all found to belong to this class, their peculiar physisal aggregation and singular inertness in acidic and basic functions making them specially fitted for interacting in the organic processes of life. Happily this preconceived bias of the organic chemist in the past is fast giving way before the active inquiry that is proceeding now into the nature of these organic colloids—the unvarying and essential constituents of the living cell. New ideas about living structures are being born out of the productive investigations of the highest order that have taken place in this field in recent years, and we may well be on the eve of another great advance in the present century which will bring us nearer the realisation of what has been Man's dream from the earliest times—*viz.*, the lifting of the curtain from the supreme mystery that enshrouds and probably ever will enshroud Life.

(*To be Continued.*)

ROYAL INSTITUTION.

A General Meeting of the Members of the Royal Institution was held on Monday afternoon, November 1, Dr. Mitchell Bruce, Vice-President, in the Chair. Mr. Atkinson, Mr. Fraser, Mr. Preston, Mr. Blythe, Capt. Hume and Mr. Cox, were elected Members.

PROCEEDINGS AND NOTICES OF SOCIETIES.

ROYAL SOCIETY OF EDINBURGH.

At the annual statutory meeting held on October 25, the following Council was elected :—

President—Principal Sir James Alfred Ewing, K.C.B., F.R.S.

Vice-Presidents—Walter Biggar Blaikie, LL.D.; Sir Robert Blyth Greig, M.C., LL.D.; Professor Thomas H. Bryce, M.A., M.D., F.R.S.; Professor E. T. Whittaker, Sc.D., LL.D., F.R.S.; James Currie, M.A., LL.D., and A. Chrichton Mitchell, D.Sc., Hon. D.Sc. (Geneva).

General Secretary — Professor R. A. Sampson, M.A., D.Sc., F.R.S.

Secretaries to Ordinary Meetings.—Alexander Lauder, D.Sc., and Professor W. Wright Smith, M.A.

Treasurer—James Watt, W.S., F.F.A., LL.D.

Curator of Library and Museum—Professor D'Arcy W. Thompson, C.B., D.Litt., F.R.S.

Councillors—Professor C. G. Barkla, M.A., D.Sc., F.R.S.; Profesor J. Graham Kerr, M.A., F.R.S., F.L.S.; Lieutenant-Colonel A. G. McKendrick, M.B.; Professor George Barger, M.A., D.Sc., F.R.S.; John Bartholomew, M.C., M.A., F.R.G.S.; Professor C. G. Darwin, M.A., F.R.S.; Professor David Waterston, M.A., M.D., F.R.C.S.E.; James Wallace Peck, C.B., M.A.; James Ritchie, M.A., D.Sc.; Professor Richard Stanfield, A.R.S.M., M.Inst.C.E.; Arthur Logan Turner, M.D., LL.D.; and G. W. Tyrrell, A.R.C.Sc., Ph.D., F.G.S.

SOCIETY OF GLASS TECHNOLOGY.

The first meeting of the Society of Glass Technology for the Session 1926-27, was held in the University of Leeds, on Wednesday, October 20, 1926, the President, Mr. Walter Butterworth, Senr., M.A., in the chair. The following papers were presented.

Glass Annealing. By DR. J. W. FRENCH, F.Inst.P.

In any discussion of annealing, the first question was the rate at which heat was dissipated by glass at the varions temperatures of the annealing process. The second—but not necessarily in order of importance—was the thermal expansion or contraction of the material. An average value of the thermal linear expansion coefficient for glass was 0.000,008,5. Thermal conductivity was the third question that required discussion. An average value of the conductivity was about 0.002. Copper had a conductivity 500 times as great. Glass was more liable to crack when heated rapidly than when cooled at the same rate. The other conditions determining the magnitude of the stresses that might be established in glass during the cooling process were :— (4) cohesion of the material, (5) the viscosity of the glass, (6) the existence of a surface layer having properties different from those of the underlying material, (7) homogeneity of the glass, and (8)the form and dimensions of the glass.

The results of defective annealing in glassware and optical glass were noted; the means of detecting stress were indicated, with special reference to the use of the polariscope; and the methods of annealing were explained. From the Optical Glass point of view, annealing meant : (1) the raising of the temperature to a point just above that of the hardest glass in the charge, and (2) the cooling of the plant at a rate which would not at any one point be sufficient to re-introduce stresses in any of the glasses. If cooling curves were plotted for all the varieties of glass, the charge should then be cooled in accordance with a curve which was the envelope of all the others. According to a method based on that of Gunand, a pot of glass was allowed to cool down comparatively quickly the rate of cooling being such that the mass would break down into pieces of a workable size. These pieces were chipped to the weight of the required rough blocks, then placed in fireclay moulds stacked in ovens. These ovens were heated until the pieces melted down and filled the moulds. They were then allowed to cool at a prescribed rate, from 3 to 4, or in some cases, 5 weeks being in general allowed for the cooling operation.

The Economics of the Annealing Process. By E. A. COAD-PRYOR, B.A.

An account was given of experiments on which the engineering department and the research laboratories of the United Glass Bottle Manufacturers, Ltd., had been recently engaged at Charlton. Ideal cooling curves for glass during the annealing process were most difficult to interpret into works practice, because they represented the temperature of the glass and not the temperature of the lehr. It was found that, by suitably grading the insulation of the

entire lehr, it was possible to carry out rapid cooling without the aid of any induced draft whatever; and further that a lehr could be built which would anneal any size of bottle without any adjustment or damper regulation.

In order to get the information on which to design a lehr on a sound theoretical basis, it was necessary to know the amount of heat taken into the lehf by the bottles and the heat lost through the lehr walls. Experiments to determine these factors were described. It was interesting to find that an alteration in the weight of the bottle being annealed did not greatly affect the heat balance; because, although the bottles took less heat into the lehr, the annealing time was very much less, and, therefore, they had only to balance the heat in the bottle with that lost from a smaller portion of the lehr. Although it was quite easy to raise a body from a temperature of 50° C., to a temperature of 60° C., with a fair degree of efficiency, it was not at all easy to add, efficiently, 10° to a body already at, say, 550° C. Eventually they decided to supply heat to the lehr by means of the slats of the conveyer, and an experimental lehr, embodying the principles outlines, was built, and proved very interesting and successful. The fuel consumption was about 18 million B.T.U.'s per day, that is, just over 100 gallons of oil, or 1,500 pounds of coal of calorific value 12,000. During most of the period of testing the lehr was running at about one-third of its maximum speed. The annealing was good throughout. They speeded it up to its maximum rate, about 10 inches a minute, and the annealing remained excellent, even on quart bottles. This speed represented an output of 450 gross of quarts per day, or about 40 tons of glass.

The lehr was fitted with a number of curtains to restrict draught up the tunnel. They found that once the curtains were adjusted to the correct setting no further adjustments were required. A thermo-couple was placed in the slat-heating chamber, close to the slats, and the only work the operator had to do was to see that the couple registered the required temperature. They found that the lehrs well retained their heat for many hours, and consequently, if the machines were shnt down (for a change of job) and the lehr was run idle for a few hours, the first bottles through after starting up again were well annealed.

Mr. F. A. Hurlbut described a suggested improvement in the design of lehr conveyers.

Mr. Edward Meigh, M.Sc., exhibited a number of lantern slides illustrating a new type of fireless lehr recently installed at the Greenford Works of the Rockware Glass Syndicate, Ltd., This lehr was the latest design of the Hartford-Empire Company, of U.S.A.

Owing to lack of time, another paper on the Agenda was taken as read, namely, *The Relationship Between Chemical Composition and othe Upper Annealing Temperature of Glasses* By S. English, D.Sc., and Proffessor. W. E. S. Turner, D.Sc.

The President announced that the next meeting would be held in Sheffield on November 17, when the Society would celemrate its tenth aniversary.

THE PHYSICAL SOCIETY AND THE OPTICAL SOCIETY.

Seventh annual exhibition of electrical optical and other physical apparatus, at the Imperial College of Science and Technology, Tuesday, Wednesday, and Thursday, January 4th, 5th, and 6th, 1927.

The Councils of the above Societies have decided again to include in the Annual Exhibition, in addition to the well-established Trade Section, a Research and Experimental Section similar to that successfully initiated in January, 1926. The groups in this section comprise :—

(a) Exhibits illustrating the results of recent physical research and improvements in laboratory practice.
(b) Effective lecture experiments.
(c) Repetitions of famous historical experiments.

Accommodation for these exhibits will be provided in rooms distinct from those devoted to the trade exhibits, and a section of the catalogue will be allotted for their description.

No charge will be made for space or catalogue entries in respect of the Research and Experimental Section, and the facilities of the Imperial College will be at the disposal of exhibitors.

The successful development of the Section depends upon the response of Research Laboratories and Institutions and individual research workers to the invitation to exhibit which the Councils of the Societies hereby give.

Offers, giving preliminary particulars of proposed exhibit, including space and other facilities required, should be addressed to the Secretary of the Physical Society at the Imperial College of Science and Technology, South Kensington, S.W.7., as early as possible, and not later than November 16th.

WIND PRESSURES ON STRUCTURES.

By Hugh L. Dryden and George C. Hill.
(*U.S.A. Bureau of Standards.*)

Abstract.

There is a general feeling among engineers that the values of the pressure exerted by the wind commonly used in the design of engineering structures are too high. The experiments on which these values are based were carried out many years ago by relatively inaccurate methods and on models not resembling actual structures. The success of modern wind tunnel methods in the field of aeronautics suggests their use for the determination of wind pressures on models of structures, and the present paper describes the results of some experiments on a model in the 10-foot wind tunnel of the Bureau of Standards.

The paper is divided into two parts, Part I being a general discussion of the subject. A general survey is given of the effects of a uniform and steady wind, and some discussion of the allowances to be made for the gustiness of the wind. Typical values of the coefficient of wind pressure are given for various types of models.

Pa trII describes experiments on a square base prism 24¼ inches high, the base being 8 inches square, at speeds up to 70 miles per hour. The pressure was measured at 70 stations on one face and 49 stations on the top for wind directions varying from 90° to one face to 90° to the opposite face by 15° steps, the ground being represented by a fixed platform and in a second series of tests by the tunnel floor.

The chief conclusions of interest to structural engineers are as follows :

1. The greatest average pressure against the building occurs when the wind blows normal to a face and is equal to 1.5 times the velocity pressure; that is, 22 lbs./ft^2 for a true speed of 76 miles per hour (100 miles per hour indicated by a Weather Bureau Robinson type anemometer).

2. The average decrease in pressure over the roof is about 0.84 times the velocity pressure; that is, 12.4 lbs./ft^2, for a true speed of 76 miles per hour.

3. The maximum moment about a vertical axis is equivalent to a horizontal displacement of the resultant force of 0.077 times the width of the building.

Conclusion.

The experiments described in the paper show the distribution of pressure over a square-base right prism of proportions 1 : 1 : 3 when resting on a fixed surface with the wind blowing normal to the axis of the prism, but at various angles to the face. The average pressure tending to overturn the building in the most unfavourable case is approximately 1.5 times the velocity pressure, corresponding to a loading of 22 lbs./ft^2 at a true speed of 76 miles per hour. (One hundred miles per hour indicated by a standard Weather Bureau Robinson-type anemometer.) Moments about a vertical axis have been computed, and it has been shown that in the most unfavourable case the moment is such as would be produced by a displacement of the point of application from the centre of the face to one side by an amount equal to 0.077 times the width of the face. The average decrease in pressure on the top is 0.84 of the velocity pressure, corresponding to about 12.4 lbs./ft^2 at a true speed of 76 miles per hour.

The values of total forces and moments, such as are quoted above, could readily have been obtained by direct measurement and the more important results of the work are the detailed studies of the contributions of the forces on each part of the structure to the total forces and moments. These results can not well be abstracted.

The discussion in this paper applies only to forces resulting from wind pressure and does not take into account lateral forces due to earthquakes or other causes.

FORTHCOMING EVENTS.

ROYAL SOCIETY OF ARTS.
John Street, Adelphi, London.

Wednesday, November 10. — Opening meeting of the one hundred and seventy-third Sessiou. Inaugural Address by Sir Thomas H. Holland, K.C.S.I., D.Sc., F.R.S., Rector of the Imperial College of Science and Technology, Chairman of the Council of the Society, on "International Interests in Raw Materials."

Indian Section.—Friday afternoons, at 4.30 o'clock.

November 12.—Sir James B. Brunyate, K.C.S.I., C.I.E., "The Report of the Indian Currency Commission." Frederick Craufurd Goodenough, Member of the Council of India and Chairman of Barclays Bank, Ltd., will preside.

ROYAL INSTITUTION.

21, Albemarle Street, London, W.1.

Tuesday, November 9, 1926.—G. W. Kaye, O.B.E., M.A., D.Sc. Lecture II. "The Acoustics of Public Buildings." Acoustical investigation of an auditorium by (a) geometry; (b) sound-pulse photography; (c) ripple-tank photography; (d) three dimensional study.

Reverberation the most common defect of public buildings. Laws of reverberation. Application to measurements of absorption. Optimum value of reverberation period for good acoustics.

Saturday, November 6, 1926.—Rev. E. M. Walker, D.D., LL.D., "Study of History: Its Value."

History part of the Legacy of Greece. For the Modern World the tradition of historical writing goes back through the Romans to the Greeks. Thucydides the father both of contemporary and of critical history.

Two questions arise. Can History predict the future? How far, and in what sense, is History a science? Influence of the Theory of Evolution on historical studies. A further question. How far should History be the history of manners? Influence of the democratic spirit on the modern conception of historical writing; e.g., Green's "History of the English People."

Thursday, November 11, at 5.15 p.m.—Sir Edgeworth David, "Antarctic Exploration." Lecture II.

Saturday, November 13, at 3 p.m.—Rev. E. M. Walker, "The Study of History." Lecture III.

INSTITUTION OF ELECTRICAL ENGINEERS.

Savoy Place, Victoria Embankment, London.

Monday, November 8, at 7 p.m.—Discussion on "The Economics of Lamp Choice. Opened by Mr. D. J. Bolton, B.Sc.(Eng.).

Dundee Sub-Centre, at University College, Dundee. — Thursday, November 11, at 7.30 p.m. Professor S. P. Smith, D.Sc., "An All-Electric House System."

BIRKBECK COLLEGE, UNIVERSITY OF LONDON.

Breams Buildings, Fetter Lane, E.C.4.
Session 1926-27.

A Course of three public Lectures on "Atoms and Isotopes," will be given by Dr. F. W. Aston, LL.D., F.R.S., Fellow of Trinity College, Cambridge, on Thursdays, 4, 11 and 18 November, at 5.30 p.m., in the Theatre of the College.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.

Ninety-sixth General Meeting at the House of the Royal Society of Arts, John Street, Adelphi, W.C.2., on Tuesday, November 9, 1926, the following paper will be read: "Oil Fuel and Other Fuels from Carbonisation Processes," by Dr. F. Mollwo Perkin, C.B.E., Ph.D., F.I.C., F.C.S., M.Inst.P.T. The chair will be taken at 5.30 p.m.

COATING MACHINES, Two, Revolving Circ. Copper Pans, Half Jacketted, 4′ 0″ dia. × 2′ 9″ deep, for coating Pills, etc. Splendid condition. By Brooks, Greenwood and Co.—Urquhart, 371, Earlsfield Road, London, S.W.

NOTICES OF BOOKS.

A Student's Manual of Organic Chemical Analysis (Qualitative and Quantitative). By J. FIELD THORPE, C.B.E., D.Sc. (Professor of Organic Chemistry, Imperial College of Science and Technology, London), AND MARTHA ANNIE WHITELEY, O.B.E., D.Sc. (Assistant-Professor at the above College). Pp. X + 250. Price 9s. net. London: Longmans, Green & Co., 39, Paternoster Row.

The authors claim, with justification, that the present work fills a blank in the early years of a student's life at many of the Universities, at which organic chemistry is more or less ignored until the final year. The book is not intended as a primer of chemistry, but rather as a work suited for students who have learned a little more than the rudiments of the science. It is of the practical kind, being a record of experience gained in twenty years' teaching in the organic laboratories of the Royal College of Science, Imperial College of Science and Technology. The value of the work is enhanced by the large number of references to standard books, published in various countries. There is given an extended appendix on new methods of organic analysis by H. Ter Meulen and J. Heslinga, and there are also published a number of useful diagrams.

Chemistry for Agricultural Students. By R. H. ADIE, M.A., B.Sc., sometime Lecturer in Chemistry, St. John's College, Cambridge. Price 5s. 6d. London: W. B. Clive, University Tutorial Press, Ltd., High Street, New Oxford Street.

Agriculture is such an important branch of industry that any work calculated to widen the horizon of knowledge bearing on the production of the land deserves commendation. The present work contains the result of many years' experience in the endeavour to shew the student how even the most fundamental facts and inferences of chemistry and physics have at once a bearing on his practical work and observations. The work, which contains a large number of diagrams, extends to 358 pages.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

25,539.—Barbet, E. A.—Production of glycerine. October 13th.

25,633.—Binz, A.—Production of substitution products of pyridine.

25,760.—British Dyestuffs Corporation, Ltd.—Manufacture of sugar, etc. October 15th.

25,659.—California Cyanide Co., Inc.—Method of making calcium cyanide, etc. October 14th.

25,265.—I. G. Farbenindustrie Akt.—Ges.—Production of carbon disulphide. Oct. 11th.

Specifications Published.

259,046.—Walker, E. E.—Manufacture of phenol-formaldehyde resins.

259,348.—Tyrer, D. — Manufacture of hydrochloric acid.

240,436.—Montecatini Soc. Generale Per L'Industria Mineraria, ed Agricola.—Apparatus for the production of synthetic ammonia.

259,395.—Hill, B. P., and Blaydon Manure and Alkali Co. (1877), Ltd.—Method for manufacturing alumina salts from alumina-silicate and alumina-containing minerals.

Printed Copies of the full Published Specification may be obtained from the Patent Office, 25 ,Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

Abstract Published.

257,418.—Tetrazoles.—Schmidt, K. F. 43, Bergstrasse, Heidelberg, Germany.

In a modification of the process claimed in the parent specification, tetrazoles are obtained by treating carbonyl compounds with excess of hydrazoic acid in the pres-

ence of concentrated mineral acids. The carbonyl compound is added to a cooled solution of hydrazoic acid in benzol, ether or tetrahydronophthalene acidified with sulphuric acid. In examples (1) cyclohexanone yields pentamethylene tetrazole, with ε-eucinelactam as a by-product. (2) acetone yields dimethyletrazole which is isolated by neutralising the acid layer of the reaction liquid, precipitating the molecular compound of the tetrazole with mercuric chloride, treating a solution of the latter with sulphuretted hydrogen, filtering and evaporating the filtrate, (3) benzophenone yields phenylamino-phenyltetrazolone.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

AMBRONITE.

472,435.—Peroxide of Manganese.—Dunford and Elliott (Sheffield) Ltd., Attercliffe Wharf Works, Chippingham Street, Sheffield. October 20th.

MAGNESIE BISMUREE.

471,262.—A medicinal preparation of magnesia for human use.—Bismag, Ltd., 7, Wybert Street, Munster Square, London, N.W.1. October 20th.

MYN-QUIN.

471,940.—Chemical substances preparer for use in medicine and pharmacy.—*Lionel George Wood, Castle Pharmacy, Station Road, Deganwy, North Wales.* October 20th.

RHEUMALAX.

473,061.—An anti-rheumatic aperient powder, being a medicinal preparation for human use.—Frederick James Evans, East End Pharmacy, 26, North Crescent, St. Annes-on-Sea. October 20th.

FRENCHMAN is prepared to give Lessons in French Grammar and Conversation.—Write, "C," c/o *Chemical News.*

GERMAN UNIVERSITY GENTLEMAN speaking English, desires to enter Firm of Manufacturing (Pharmaceutical) Chemists. Has good knowledge of Elementary Chemistry, with First-Class Certificates in Theoretical and Practical Work, gained at the City of London College; and Business Experience.—Write, Box A. Z., *Chemical News*, Merton House, Salisbury Square, London, E.C.4.

UNIVERSITY OF BIRMINGHAM.

LECTURER IN DEPARTMENT OF CHEMISTRY.

Applications are invited for the post of LECTURER IN ORGANIC CHEMISTRY. Stipend, £400 per annum. Duties to begin January 11, 1927, or earlier if possible. Four copies of application, with references must be sent, on or before October 30th, to the undersigned, from whom further particulars may be obtained.

C. G. BURTON.
Secretary.

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A COMPACT AND COMPREHENSIVE SERIES OF REACTIONS AND TABLES IN CHEMISTRY.

By ROBERT SAXON, B.Sc., F.C.S.

(*Continued from Page 198.*)

HYDRIC ACID, CONTINUED.

MORE REPLACEMENT OF RADICLES BY HYDROXYL.

i $BeSO_4.2HOH$ /t $Be(OH)_2/H_2SO_4$

ii $MgS/2HOH$ n/- $Mg(OH)_2/H_2S$, thus heat is evolved, as the n indicates.

iii $MgSO_4.7HOH$ /t $MgO/H_2SO_4/6HOH$

iv $CaS/2HOH$ % $Ca(OH)_2/H_2S$, also Sr, and Ba.

v $Al_2S_3/3HOH$ $Al_2O_3/3H_2S$, also Sc. Y. La, etc., also B_2.

vi $In_2(SO_4)_3/HOH$ /t basic salt. also Tl

vii CS_2/HOH /sl CS/H_2S /O (sunlight)

viii $SiS_2/4HOH$ $Si(OH)_4/2H_2S$

ix $TiS_2/4HOH$ - $Ti(OH)_4/2H_2S$, hydrate indefinite

x $2Ce(SO_4)_2/3HOH$ - $Ce(OH)_3$ $Ce(SO_4)_2/2H_2SO_4/2H$

xi $Na_2Se/2HOH$ - $2NaOH/H_2Se$, also selenides and tellurides in cases where sulphide hydrolyses

xii $Cu_2S/4HOH$ /bp $2CuO/SO_2/8H$

xiii $Li_3N/3HOH$ - $3LiOH/NH_3$, also K_3N

xiv $NaNH_2/HOH$ - $NaOH/NH_3$, also KNH_2

xv $Be_3N_2/6HOH$ n/- $3Be(OH)$ $/2NH_3$, also B_3P_2

xvi $Be(NO_3)_2/2HOH$ /t $Be(OH)_2$ $2HNO_3$

There are a tremendous number of acid salts, that is which contain ionised hydrogen, and give acid reaction with indicators. These only do so where water is present, and the hydrogen ion can only proceed from the water. The above reaction is probably what takes place with all of them, that is hydroxyl replaces the acid ion. The insolubility of the hydrate might as easily be due to the activity and affinity of the hydroxyl as the cause of its formation.

xvii $Mg_3N_2/6HOH$ - $3Mg(OH)_2/$ also Mg_3P_2, and Mg_3As_2

xviii $Zn_3N_2/3HOH$ - $3ZnO/2NH_3$, also Hg_3N_2

xix $Cd_3N_2/3HOH$ xxx $3CdO/2NH_3$, reaction takes place with violence as the xxx indicates.

xx $Ca_3N_2/6HOH$ /bp $3Ca(OH)_2/2NH_3$, a means of making ammonia from the air.

xxi $Zn_3N_2/3HOH$ it/- $3ZnO/2NH_3$ incandescent temperature produced.

xxii $Hg_3N_2/3HOH$ xxx $3Hg/2NH_3/3O$

xxiii Sr_3N_2 and phosphides and arsenides of all these behave in the corresponding way as Ca_3N_2

xxiv $Mg_3N_2/3HOH$ bp/- $3MgO/2NH_3$, that is the heat evolved is sufficient to boil the water.

xxv $Zn(NH_2)_2/2HOH$ bp/- $ZnO/2NH_3/HOH$, the water becom-

......

ing vapourised. Also Cd salt.

xxvi (vac($3Cd(NH_2)_2$ /t $Cd_3N_2/4NH_3$)), meaning that the reaction takes place in vacuo.

xxvii $AlN/3HOH$ $Al(OH)_3/NH_3$, also AlP, AlAs.

xxviii $2Ga(NO_3)_2/3HOH$ /wt $Ga_2O_3/6HNO_3$,

and nitrates as well as sulphates of this group are acid to indicators. The alums are acid also. This applies to Tl and In salts. The nitrides, etc., of this group all hydrolyse and betray ionised hydrogen in solution,, which becomes cloudy

xxix $CO(NH_2)_2/2HOH$ - $CO(OH)_2/2NH_3$
$CO(OH)_2$ CO_2/HOH

xxx KCN/HOH - KOH/HCN

Cyanides smell of HCN when moist, due to hydrolysis.

xxxi $KC_2H_5SO_4/HOH$ - $C_2H_5OH/KHSO_4$

xxxii $C_6H_5N_2SO_4/HOH$ /bp $C_6H_5OH/H_2SO_4/N_2$

xxxiii $Fe(CH_3O_2)_3/2HOH$ - $Fe(OH)_2(CH_3O_2)$ $/2CH_3COOH$

xxxiv (($Ca(CN)_2/KOH/3HOH$ /t $CaCO_3/2NH_3$)).

The reaction takes places in confined space, as the brackets show. As the KOH only appears on one side, it is a catalyst.

xxxv $Si/2KOH/HOH$ /bp $K_2SiO_3/4H$.

As the silicate is always hydrated we must assume that the water first produces the hydroxide of silicon, as it would with a great number of oxygen-loving elements.

xxxvi $Na_2SiO_3/2HCl/HOH$ - $2NaCl/Si(OH)_4$, also K_2SiO_3

Insoluble silicates do not act so.

xxxvii Na_2TiO_3/HOH - $NaOH/NaHTiO_3$

xxxviii $Zr_3N_2/6HOH$ /t $3ZrO_2/2NH_3/6H$, also Ti_3N_2

xxxix TiP/xHOH /bp ZrO_2/ etc., also ZrP

xl $2Sn(NO_3)_4 4HOH$ - $2SnO_2/8HNO_3$

xli $Sn(NO_3)_4/4HOH$ - $Sn(OH)_4/4HNO_3$

xlii VN/xHOH O/- (no action), also CbN, TaN

xliii Same applies to nitrides of Cr, Mo, W, and U.

xliv Same with phosphides of all these metals,
$U_3P_2/9HOH$ - $3UO_3/2PH_3/12H$

xlv $Fe_2N/6HOH$ - $2Fe(OH)_3/NH_3/3H$

xlvi $2HgNO_3/HOH$ - $HgOHHgNO_3/HNO_3$

xlvii $Na_2C_2O_2/2HOH$ xxx $2NaOH/HOH/C/CO$, also $K_2C_2O_2$

xlviii Ag_2CO_3/HOH /bp $Ag_2O/HOH/CO_2$

xlix $MgCO_3/HOH$ /bp $MgO/HOH/CO_2$

l $BeC_2/4HOH$ - $BeO/2CH_4/3O$

li $Mg_2C_3/2HOH$ - $2MgO/C_3H_4$

lii $CaC_2/2HOH$ - $Ca(OH)_2/C_2H_2$, also BaC_2

liii $Al_4C_3/12HOH$ - $4Al(OH)_3/3CH_4$

liv B_6C/xHOH O/- (no action)

lv Carbides of this group vary in composition, but hydrolyse, giving various hydrocarbon mixtures.

lvi $TiC/4HOH$ /bp $Ti(OH)_4/CH_4$, also ZrC

As the carbides generally are formed at great heat, and their elements would exist as such in the anti-compound age of the earth, these elements would in all probability unite to form carbides as cooling made this posible. Later, steam would hydrolyse them, producing the oxides, and their salts as titanates, zirconates, silicates,

etc., and hydrocarbons would result. Borides and silicides as carbides.

Hydrides generall are all decomposed by water either cold or heated.

lvii $CeH_3/3HOH$ xxx $Ce(OH)_3/6H$

lviii $PrH_3/3HOH$ xxx $Pr(OH)_3/6H$

lix $SiH_4/4HOH//CoO$ /t $Si(OH)_4$ /8H.

The double // signifies that the CoO acts as a catalyst.

lx $SiH_4/2KOH/xHOH$ /t K_2SiO_3 /yHOH/6H

lxi $ThH_4/2HCl/HOH$ - $ThOCl_2/8H$

lxii $2SbH_3/4HOH$ $2HSbO_2/12H$

lxiii $Na_2Zn_2O_3/HOH$ - $2NaOH/2ZnO$ also K, NH_4, Ca, Sr, Ba salt and corresponding Cd salts.

lxiv Na_2PbO_3/HOH - $2NaOH/PbO_2$ also K salt.

lxv $Na_2ZrO_3/3HOH$ - $2NaOH/Zr(OH)_4$

lxvi $Ca_2PbO_4/4HNO_3/HOH$ - $2Ca(NO_3)_2/PbO_2$ also Sr, Ba salts.

lxvii $Li_2UO_4/2HOH$ - $2LiOH/H_2UO_4$

Most of the tungstates yield the acid with water, as do the ferrites, ferrates, ruthenates, osmiamates, osmates, etc.

lxviii $2PbCrO_4/HOH$ - Pb_2CrO_5/H_2CrO_4

lxix $2Bi(NO_3)_3/2HOH$ - $Bi_2O_3N_2O_5/4HNO_3$

lxx $Bi_2(SO_4)_3/2HOH$ - $2H_2SO_4/Bi_2O_3SO_3$

lxxi $Ca_3(PO_4)_2/6HOH$ /t $3Ca(OH)_2/2H_3PO_4$ to form $Ca(OH)_2Ca_3(PO_4)_2$

Hydrogen sulphide is looked upon as an acid though water is not; and yet oxygen has more acid tendencies than sulphur, and hydroxyl than hydrosulphyl SH.

lxxii $P_2S_3/3HOH$ - $P_2O_3/3HSH$

lxxiii $P_2S_5/5HOH$ - $P_2O_5/5HSH$, and these oxides like all the oxides of phosphorus, unite with water to form the acids of phosphorus.

lxxiv $V_2O_4/HOH/O$ (air) - $2HVO_3$

lxxv $2Hg_3PO_4//HOH$ - $Hg_3(PO_4)_2/3Hg$

lxxvi $2As(NH_2)_3/3HOH$ $As_2O_3/6NH_3$

lxxvii $2AsN/3HOH$ - $As_2O_3/2NH_3$

Hydric Acid, the Acid Maker.

Water unites with many oxides to form acids. Alcohol or phenol cannot do this, although the resultant compound would be richer in hydrogen than the acid is. The oxide itself has no acid reaction to indicators even in liquid state, and at high temperature, unless water is present. Water may thus be considered a self complacent couple compounded, and this complacency is seriously upset by the introduction of these acid oxides. Here are a few examples of water making acids with the oxides of mostly negative elements :—

i : B_2O_3/HOH n/- $2HBO_2$

The symbol : always connected with water means that the compound following it is hygroscopic or deliquescent. As before the n shows that heat is evolved. The after the / shows that this takes place at the ordinary temperature of the air.

ii : $B_2O_3/3HOH$ n/- $2H_3BO_3$

iii $2B_2O_3/HOH$ n/- $H_2B_4O_7$

iv Al_2O_3/HOH $H_2Al_2O_4$

v CO_2/HOH - $H_2 : CO_3$

The symbol : means that the compound is ionised, and the group after it will remain intact when transferred to another base. It cannot be confused with the previous one. It also, as in arithmetic, shows a ratio, in this case two atoms of hydrogen with four atoms, one of carbon and three of oxygen. It might therefore be written $4H : 2CO_3$ for double the quantity, $6H : 3CO_3$ treble the quantity, etc., the ratio remaining the same. When a compound is written thus it means that the compound exists in solution, generally only so.

vi N_2O/HOH % 2HNO (only partially so)

vii N_2O_3/HOH - $2HNO_2$

viii N_2O_4/HOH /-t HNO_2/HNO_3 (temp. below zero)

ix N_2O_5/HOH - $2HNO_3$.

These acids exist only as $2H : 2NO$, $H : NO_2$, and $H : NO_3$, respectively. With such unstable solutes as these we cannot give their exact formula; we can only indicate the ratios among the component elements. Nitric acid may be $H : NO_3$ or $xH : xNO_3$, x being unknown.

x $P_4O_6/6HOH$ / - - - $4H_3PO_3$

meaning that at ordinary temperatures the reaction goes very slowly. Note that the indicator - - - is on the supply side of /.

xi $P_4O_6/6HOH$ xxx/t $4H_3PO_3$

The symbol means 'very vigorously,' and is on the resultant side of the /, meaning that the energy is produced by the reaction, whereas the t means that heat must be supplied to start.

xii $P_2O_4/3HOH$ n/- H_3PO_3/H_3PO_4

xiii P_2O_5/HOH n/- $2H : 2PO_3$

xiv $P_2O_5/2HOH$ n/- $H_4P_2O_7$

xv $P_2O_5/3HOH$ n/- $2H_3PO_4$

xvi $V_2O_4/HOH/O(air)$ - $2H : 2VO_3$

xvii V_2O_5/HOH - $2H : 2VO_3$

xviii $V_2O_5/2HOH$ - $H_4 : V_2O_7$

xix $As_4O_6/2HOH$ $4H : 4AsO_2$

xx As_2O_5/HOH - $2HAsO_3$

xxi $As_2O_5/2HOH$ - $H_4As_2O_7$

xxii $As_2O_5/3HOH$ - $2H_3AsO_4$

xxiii Cb_2O_5/HOH O/t
(No action since no calories are evolved, even on heating)

xxiv $Ta_2O_5/HOH/H_2SO_4$ O/t

xxv Sb_2O_3/HOH - - - $2H : 2SbO_2$

xxvi Sb_2O_5/HOH O/t

$HSbO_3$, $H_4Sb_2O_7$, and H_3SbO_4 obtained from salts giving a precipitate with the mineral acids.

xxvii SO_2/HOH - $H_2 : SO_3$

xxviii SO_3/HOH 39/- $H_2 : SO_4$
39 Cals. are evolved.

xxix CrO_3/HOH - $H_2 : CrO_4$

It is worthy of note that these powerful acids are powerless without water, and strong sulphuric acid is responsible for a great number of reactions by virtue of its strong affinity for water, in other words has a strong tendency to ionise itself.

xxx $2SO_3/HOH$ - $H_2 : S_2O_7$

xxxi $2CrO_3/HOH$ - $H_2 : Cr_2O_7$

xxxii $S_2O_7/3HOH$ - $2H_2 : 2SO_4$ $H_2 : O_2$ (?)

xxxiii $Cr_2O_7/3HOH$ - $2H_2 : 2CrO_4$ $H_2 : O_2$ (?)

xxxiv SeO_2/HOH - H_2SeO_3
H_2SeO_4 obtained from salts.

xxxv TeO_2/HOH - H_2TeO_3
H_2TeO_4 obtained from salts.

xxxvi MoO_3/HOH % - - - H_2MoO_4 (only partially, and very slowly). H_2MoO_4, H_2WO_4, and H_2UO_4 are prepared from salts as precipitates. $H_2Mo_2O_7$, $H_2Mo_4O_{13}$, $H_2Mo_8O_{25}$ are given as soluble in water, $H_2W_4O_{13}7HOH$ is soluble whilst H_2WO_4 is insoluble in water. H_4UO_5 is insoluble.

xxxvii Cl_2O/HOH - $2H : 2ClO$

xxxviii Cl_2O_3/HOH - $2H : 2ClO_2$

xxxix $2ClO_2/HOH$ - $H : ClO_2/H : ClO_3$

xl Cl_2O_3/HOH - $H : ClO_4$
Thus it will be seen that these oxyacids of chlorine only exist in solution.

xli $H : ClO_4/xHOH$ /t : $HClO_4$ HOH/water.

From this we see that perchloric acid is the most stable, and from the symbol which precedes the formula, it is deliquescent.

xlii I_2O_5/HOH - $2H : 2IO_3$

xliii I_2O_7/HOH - $2H : 2IO_4$

xliv $2H : 2IO_4/xHOH$ /t : $2HIO_4$ 4HOH/ water

xlv $I_2O_7/2HOH$ - $:H_4I_2O_9$

xlvi $2MnO_3/HOH$ - $H : MnO_4/MnO_2$

xlvii Mn_2O_7/HOH - $2H : 2MnO_4$

Ferrates, osmates, etc., do not furnish the oxide, and the acid only exists in water or water and alcohol.

WATER, THE HYDROXIDE MAKER.

Water unites with oxides to form hydrates or hydroxides. As most hydrates or oxides of metals are insoluble in water

the number of hydroxides thus formed is small.* Thus, though water is pre-eminent as an acid, essential oxides can neutralise acids without its aid.

i Li_2O/HOH n/- 2LiOH
also Na_2O, K_2O, Rb_2O, and Cs_2O. The peroxides yield oxygen also.

ii Ag_2O /HOH % 2AgOH

iii Cu_2O/HOH O/-

iv CaO/HOH n/- $Ca(OH)_2$
also SrO, BaO, BeO, MgO, ZnO, CdO, HgO, O/-.

v Tl_2O/HOH - 2TlOH

vi Pb_2O/2HOH - $Pb(OH)_2PbO$/2H (?)

It also reacts with metals, much more readily than oxides, and as with an acid hydrogen is evolved.

vii Li/H : OH - Li : OH/H
also Na, K, Rb, Cs.

viii Ca/2H : 2OH n/- Ca : 2OH/2H

Such examples justify the writing of water as HOH or H :OH, for one of the hydrogen atoms is associated with the oxygen and the other free.
Also Sr and Ba.

ix Mg/.2HOH - %%% $Mg(OH)_2$/2H.

The . before the HOH means "finely divided," and that can only be moist air. %% means exceedingly small percentage.

x Mg/HOH O/bp. Thus boiling water has no action.

xi .Mg/HOH /200d MgO/2H, also
......
Zn

xii Al/3HOH //bp $Al(OH)_3$/3H.
The sign // means slow reaction, /// would mean exceedingly slow.

xiii Al/3HOH xxx/700d $Al(OH)_3$/3H

The reaction is very rapid at a temperature of 700 degrees centigrade.

xiv $2Al(OH)_3$ /700d Al_2O_3/3HOH

xv Y/3HOH /t $Y(OH)_3$/3H, also *La etc., except Ga, In, Tl.

xvi Mn/2HOH xxx $Mn(OH)_2$/2H

xvii 3Fe/4HOH /rt Fe_3O_4/8H
......

There is always some hydrate along with the oxide, which only forms because the hydrogen is led away from the scene of action. Otherwise the reaction would reverse itself after a time.

CONTRACTIONS IN SOLUTION.

Mr. J. N. Rakshit has recently published three papers in the *Zeitschrift für Electrochemie* containing his results of study in contractions in solutions of about 60 representative inorganic and organic substances, using water, benzene, methyl alcohol, ethyl alcohol, acetone, glycerine, acetic acid, nitric acid and sulphuric acid as solvents. His results show striking similarity in the phenomenon in cases of electrolytes and non-electrolytes. The author has introduced a new chemical term "molecular contraction in solution," which indicates contration in c.c. occuring on solution of a gram-molecule of a solute in any fixed quantity of a solvent. He has also determined such figures for aqueous solutions of potassium chlorate, sodium carbonate, sodium sulphate, calcium dihydrate, cadmium 8/3 hydrate, and of ethyl alcohol at different concentrations and at different temperatures ranging from 10° to 60° C. An important fact is now revealed that decahydrates of sodium sulphate and sodium carbonate do not lose their hydration in solution at above 33° C.

The author has criticised Nernst's method of determination of hydration of ions and also stated that much of Hildebrand's mathematical calculations in his "Solubility" lose importance through their ignorance of the contraction in solution. The error due to neglect of contraction in solution may not be much yet it should be taken into consideration while dealing with so fine mathematics. The results clearly show that most of the earlier thermo-chemical measurements must have been influenced by temperature and concentration.

Opinions from the advocates of theory of ionisation in solution are invited for any interpretation of these results in consideration of the fact that they bring forward a striking similarity between solutions which conduct electricity and those which do not.

These results are in agreement with his theory that association between solute and

solvent occurs on dissolution and varies with dilution. Molecular contraction, a function and an indication of such phenomenon, decreases with increase of temperature.

These determinations open a new subject of investigation, which promises to throw some light on the many unsolved problems of theory of solution. We congratulate Mr. Rakshit and anxiously await further results.

JOSEPH PRIESTLEY—AN APPRECIATION.

(Abstracted from a lecture delivered by Dr. Edgar F. Smith, at the anniversary of the American Chemical Society, on which occasion the Priestley Medal was presented to Dr. Smith. Reported in "Science," October 1, 1926.)

"The intelligent world marvels and admires the ubiquitous manifestations and astounding properties of at least one elemental body, *viz.*, oxygen. Its discoverer —from the humble walks of life—a simple-minded pedagogue—was not, on the other hand, so universally admired and appreciated, indeed, was despised, hated and persecuted by untold multitudes of his countrymen, so that in 1794 and for years later, at intervals, he might have been seen walking the streets you all have trodden on your perambulations through this city, in this thanksgiving period represented in the Sesquicentennial celebration of our loved Republic. Here, in due course, the discoverer of oxygen, gathered with our earliest scientists. In a modest, unattractive structure on Fifth Street, midway between Chestnut and Walnut Streets, bearing the name 'Anatomical Museum,' he witnessed on several occasions experimental demonstrations of the non-existence of that fatuous, evanescent non-entity—phlogiston,

In the now ancient abode of the American Philosophical Society — diagonally across the way from the Anatomical Museum—he mingled with the membership of that august body and gave expression at times to his views on topics under discussion; pleasing by his urbanity, by the display of broad scholarship, by his genius, by his scientific interests, to such a degree that some years subsequently he was obliged to peremptorily decline the use of his name for the presidency of the society.

At the south-west corner of 4th and Locust streets is a handsome colonial home. There resided the eminent Caspar Wistar. There, quite often, congregated the first men of the city—first in national affairs, in commerce, in the learned professions, in science and in literature. Frequently, he of whom I speak could have been observed there. He was happy in the company of dignified and brilliant men. He loved to be with them. He was deeply appreciated and eagerly sought after because of his winning ways, his tolerance and liberality.

Such was the one whom, as chemists, we justly revere, and who as frequently described was one 'whose genius, like a star of dazzling resplendance, shines with conspicuous lustre in the galaxy of his brilliant contemporaries—the philosophick Priestley.

But he was more :

(1) A writer, the philanthropy of whose heart never slept.

(2) A metaphysician—truly the first of his age.

(3) A politician who assiduously laboured to extend aud illustrate those general principles of civil liberty which are happily the foundation of the constitution of his adopted country.

(4) A man who inspired the readers of his generation to *think* and investigate beyond any writer of his day.

Chemists everywhere should read not alone his communications setting forth the discovery of oxygen, but all his scientific publications. The science world of his day viewed them as epoch-making, for they appeared in splendid translations in all the languages of contemporary Europe.

Then should be read his lectures on oratory and criticism and on general history, as well as his volume on 'Perspective,' that his profound attention to literature in general, as well as to art, may be noted.

Ten years before discovering oxygen—that was iu 1764—Joseph Priestly wrote an 'Essay on a Course of Liberal Education for Civil and Active Life.'

A few years subsequently he wrote 'Remarks on a Proposed Code of Education,' and a third and rather lengthy document, possibly influenced thereto by Benjamin Franklin, on 'Miscellaneous Observations Relating to Education, more especially as it respects the Conduct of the Mind.'

And uow—quite recently has appeared a very interesting and learned article in which

the writings of Herbert Spencer and Joseph Priestley are compared—extracts from their publications being printed side by side and closely contrasted. The concluding paragraph of this startling communication reads :

'In their non-Conformist position, their opposition to State control of education, their individualism, their radical attitude on science, their utilitarianism, the two men agree closely. It is not strange that Herbert Spencer should have gone to this intellectual ancestor of his for ideas; but it is singular that the debt shaold not have been discovered before; and it is noteworthy that the debtor on every occasion fought vigorously in defence of his various claims for priority. Spencer's chief additions to Priestley's eighteenth-century thought were a slashing style and a brilliant faculty for special pleading. Few, if any, other writers on education have attained a great reputation so cheaply but perhaps fame rarely conforms to the facts.'

But I must stop. Another side of this versatile brother chemist has been called up; and when he is properly understood and known, future generations will encircle his name with 'those never-fading wreaths, compared with which the laurels that a Cæsar reaps are weeds.'

We chemists of America, holding high that name, glory in the privilege of 'doing honour . . . to Priestley, the peerless defender of national freedom in thought and in action; to Priestley the philosophical thinker; to that Priestley who held a foremost place among 'the swift runners who hand over the lamp of life,' and transmit from one generation to another the fire kindled, in the childhood of the world, at the Promethean altar of science.' "

General Notes.

BOARD OF TRADE ANNOUNCEMENT.

Safeguarding of Key Industries.

The Board of Trade give notice that representations have been made to them under Section 10 (5) of the Finance Act, 1926, regarding the following articles :—

Amidopyrin, barbitone, cocaine, cocaine hydrochloride, guaicol carbonate, hydroquinone, methyl sulphonal, oxalic acid, phenacetin, phenazone, piperazine, salol sulphonal.

Section 10 (5) of the Finance Act is as follows :—

" The Treasury may by order exempt from the duty imposed by section one of the Safeguarding of Industries Act, 1921, as amended by this Act, for such period as may be specified in the order, any article in respect of which the Board of Trade are satisfied on a representation made by the consumer of that article that the article is not made in any part of His Majesty's Dominions in quantities which are substantial having regard to the consumption of that article for the time being in the United Kingdom, and that there is no reasonable probability that the article will within a reasonable period be made in His Majesty's Dominions in such substantial quantities."

Any person desiring to communicate with the Board of Trade with respect to the above-mentioned applications should do so by letter addressed to the Principal Assistant Secretary, Industries and Manufactures Department, Board of Trade, Great George Street, S.W.1., within two months from the date of this notice.

Board of Trade.

27th October, 1926.

CANADIAN MINING NOTE.

During the past twelve months there has been considerable interest in exploring the extension northwards from the Flin-Flon area of the western division of The Pas mineral district. This has been caused by the discovery of a copper-zinc ore body east of Kississing (Cold) lake, which was diamond-drilled last winter and spring by the Eastern Canada mining interests represented by Messrs. Fasken and Earle. There has resulted very considerable prospecting in the Cold Lake area and southwards. The Sherritt property is 35 miles north and 12 miles east of the Cranberry portage, over which the railway to the Flin-Flon property from The Pas would pass. By canoe route it is four days from Sturgeon Landing, at the head of steamboat communications from The Pas. By this discovery the area of active prospecting has been extended to 50 miles in a north and south direction at the west end of the belt, which extends in Manitoba eastwards from the boundary for over 90 miles.

SPONTANEOUS COMBUSTION.

The main cause of the spontaneous combustion of coal is most often direct action of the oxygen of the air on the coal substance. Coal is a conglomerate of widely differing compounds, as is shown by the readiness with which a bituminous coal can be divided by means of organic solvents into fractions that differ in general character.

A paper by W. Francis and R. V. Wheeler entitled: "The Spontaneous Combustion of Coal: The Most Readily Oxidisable Constituents of Coal" (Safety in Mines Research Board Paper No. 28, H.M. Stationery Office, Adastral House, Kingsway, London, price 1s .6d. net), gives an account of recent work designed to determine which constituents of the coal-conglomerate are most readily attacked by oxygen.

MARKING OF GILT, SILVERED, ETC., ARTICLES IN FRANCE.

The French *Journal Officiel* for 22 October contains a Presidential Decree, dated 20 October, which provides that French or foreign articles which are simply gilt, silvered, or platinum-coated, must not be described as rolled or plated (" plaqué " or " doublé "), even if the precious metal used is also indicated, but must be stamped with the words " doré " (gilt), " argenté " (silvered), or platiné " (platinum-coated), as the case may be. A period of three months from the date of publication of the Decree is allowed for manufacturers and importers to conform to its provisions.

INCREASED GOLD PRODUCTION IN CANADA.

Canada's gold production is still increasing. Production during the first six months of 1926 amounted to 885,813 fine ounces, valued at $18,311,378, as compared with 824,043 ounces valued at $17,034,480 during the first half of 1925. Ontario mines were credited with 754,274 ounces, valued at $15,592,220; British Columbia produced 123,816 ounces valued at $2,559,509; Yukon Territory production was determined as 4,852 ounces, valued at $100,800; Quebec was credited with 1,929 ounces worth $39,876, which was obtained from the ores exported during the period.

TO SUPPLY NATURAL GAS FOR INDUSTRIAL PURPOSES (CANADA).

According to a statement by Mr. H. I. representative of Mr. E. J. Roth, an independent oil and gas operator in the United States, all arrangements have been completed for bringing gas for industrial purposes only from the Turner Valley field to Calgary. Mr .Cowan intimated that construction of a pipe line would commence as soon as the Public Utility Board fixes the rate for industrial gas in Calgary. The company would operate in competition with the Canadian Western Natural Gas Light, Heat and Power Company and the great significance of the statement is that a use for the surplus gas from the Turner Valley is assured. The financial interests which Mr. Cowan represents purpose establishing a carbon block plant to utilise any of the waste gas which cannot be sold for industrial purposes.

INSTITUTE OF CHEMISTRY.

The Institute advises Fellows and Associates in the Overseas Dominions and elsewhere abroad that they are represented on the Council by Dr. Frankland Dent, is glad to meet such members (when home on leave) at the Institute by appointment. They will always find a welcome at headquarters, and it is proposed, when a number of such members are in London, to arrange meetings for them in order to facilitate an exchange of views regarding the interests of the profession in different parts of the Empire.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

The following papers were read on Thursday, November 4.

Experiments on the Production of Large Copper Crystals. By H. C. H. CARPENTER, F.R.S., AND S. TAMURA.

Crystals exceeding 4 inches in length have been grown in poly-crystalline copper strip of section 0.5 inch × 0.125 inch by the method of critical strain followed by appropriate heat treatment. These crystals, however, are not strictly speaking, single crystals, since they contain numerous twins which may be oriented in as many as three directions. It has not been found possible to produce large copper crystals by this method without at the same time producing twins. The complete removal of

strain in recrystallised copper strip is only achieved by prolonged heating. On account of the presence of twins, the large crystals thus prepared only possess about one-third of the ductility of polycrystalline copper. Their tenacity, however, is almost the same. Their ductility is still more inferior to that of single-crystal copper prepared direct from the liquid which is free from twins.

The Formation of Twinned Metallic Crystals. By. H. C. H. CARPENTER, F.R.S., AND S. TAMURA.

Experiments on "annealing twins" have been made principally with copper and certain of its alloys. These are produced by straining followed by heat treatment, during which recrystallisation and crystal growth occur. These twins are structurally very stable. Specific instances of twinning in other metals and alloys have also been investigated. It is suggested that the principal cause of twinning is crystal growth. Deformation is an indirect cause of twinning, merely because it causes subsequent growth on annealing. In some cases the orientation of annealing twins indicates that they have grown along certain crystalographic directions. Most frequently they are rectilinear, but sometimes they are markedly curved.

The capacity for forming annealing twins appears to be closely related to the atomic arrangement in the crystal lattice of the metal. Those metals which crystallise in the face-centred cubic, tetrahedral cubic, and face-centred tetragonal lattices produce annealing twins after suitable treatment, whereas metals possessing other atomic arrangements have not been found to produce them. Fine strain-etch lines may be developed in any metal after appropriate treatment, but they vanish entirely on heating. Metals which crystallise in the close-packed hexagonal lattice, *e.g.*, zinc and cadmium, have no possible planes of twinning, and what is called twinning in these metals is probably parallel growth.

The Distortion of Iron Crystals. By G. I. TAYLOR, F.R.S., AND C. F. ELAM.

Specimens cut from crystals of iron were subjected to uniform distortion both in compression and in tension. The distortion was analysed and the orientations of the crystal axes determined by X-rays. It was found that the distortion is due to slipping in a direction parallel with the perpendicular to a [111] plane. This plane of slip had different orientations with respect to the crystal exes in different specimens. It was not a crystal plane and its orientation round the direction of slip was determined chiefly by the direction of stress. A uniform shear for which the direction of slip is a crystal axis while the plane of slip is not a crystal plane, could arise from simultaneous slipping on two crystal planes in the direction of their line of intersection, or it could be due to a condition of slipping in which the particles of the material stick together in rods instead of in planes. The first of these hypotheses is rejected and the second accepted.

This conception of the mechanism of distortion in iron accounts for the fact, proved in the course of the work, that the general direction of the slip lines which appear on a polished surface coincides with the trace of the plane of slip and has no direct connection with the crystal axes. It also leads to the prediction that if a specimen were cut with a polished face parallel to the direction of slip, the slip lines would be straight, whereas the lines on a face making a considerable angle with the direction of slip should be jagged or curved in detail while preserving a general straightness or uniformity of direction. This prediction is strikingly verified by micro-photographs.

The Polymorphism of Silicon Dioxide and the Structure of Tridymite. By R. E. GIBBS. Communicated by Sir William Bragg, F.R.S.

After giving a review of the β-structures of quartz and crystobalite, a structure has been suggested for the intermediate form tridymite, on the assumption of the conservation of the tetrahedron of oxygen atoms around any silicon as the building unit. X-ray analysis justified this assumption, and thowed that the structure of tridymite was similar to that of ice, *i.e.*, D^{4}_{6h}, with four molecules per cell, in which $a = 5.03$ and $c = 8.02$. A comparison of structure illustrates how some of the symmetry elements of the tetrahedron have been conserved in each case. It follows that the structures are good examples of that class in which the framework can be considered as a close-packed arrangement of oxygen atoms of diameter about 2.6, whilst the silicon atoms occupy the spaces formed between four neighbouring oxygens. It is probable that the structures are ionic in nature, being variations of a two-to-one packing of oppositely charged ions.

Possible modes of β-β transitions lead to the idea that these sluggish changes are

characterised by a change of partners between neighbouring ions. On the other hand, the α-β transition in the case of quartz at least, and probably in the other forms as well, is merely a small atomic rearrangement not sufficiently drastic to involve a change of neighbours. The α-states are probably created by distortions of the β-forms involving lower symmetry and possibly larger cells. α-tridymite is orthorhombic, having a cell $a = 9.9$, $b = 17.1$, $c = 16.3$, in which the units must be polymerised groups $nSiO_2$, where n is larger than two and probably equal to eight. Lastly, the existence of a third form α' of tridymite was confirmed and shown to resemble fairly, as far as could be judged photographically, the ordinary α-form.

THE CHEMICAL SOCIETY.

Papers read on November 4.

The Structure of the Benzene Nucleus. Part V. Some Meso-derivatives of Anthracene. By C. K. Ingold and P. G. Marshall.

As the result of a study of a number of 9 : 10-diaryl-anthracenes and substituted diarylanthracenes, it was shown (a) that these substances exhibit properties corresponding with those of the hexa-arylethanes, (b) that in electrically dissociating solvents the dissociation is partly ionic, (c) that the ion is tautomeric, (d) that substituents affect dissociation in the manner which analogy with hexa-acylethanes and the dissociating tetra-arylhydrazines would suggest, (e) that the coorimetric determination of the degree of dissociation yields results consistent with a reversible unimolecultr reaction.

The Nitration of S-Methylthioguaiacol. By A. Pollard and R. Robinson.

It was shown that, contrary to the statements of Holmes, Ingold and Ingold, the action of nitric acid on S-methylthioguaiacol yields 5-nitro-2-methoxyphenylmethylsulphoxide. In the formation of this substance oxidation precedes nitration and the 6-nitro-2-methoxy-*S*-methylthiophenol of the above authors is really 2-methoxyphenylmethysulphoxide.

The isomerism of Molybdenyl Monochloride. By W. Wardlaw and R. L. Wormell.

From solutions of tervalent molybdenum, a buff and a green oxychloride, $MoOCl, 4H_2O$ have been isolated. Conductivity measurements indicate that these are correctly formulated as the co-ordination compounds. On the assumption that the six associating units are octahedrally distributed round the central metallic atom, these substances correspond with *cis* and trans isomerides. By the action of monosodium salicylate with these isomerides, proof has been obtained that the buff solid has a *cis* and the green solid a *trans* configuration. This furnishes the first demonstration that molybdenum can give rise to co-ordination compounds in accordance with Werner's view of their six-fold structure.

The Inhibitory Effect of Substituents in Chemical Reactions. Part I. The Reactivity of the Nitrogen Atom in Substituted Arylamines. By G. M. Dyson, H. J. George, and R. F. Hunter.

The inhibitory effect of a substituent on the reactivity of an arylamine depends both on its steric and on its polar character, the latter being the more important.

In the reaction between thiocarbonyl chloride and arylamines: (1) No possible combination of nuclear methyl groups affects the reactivity of the arylamino-complex. (2) Hydroxy- and alkoxy-substituents show scarcely any appreciable hindrance effect. (3) Halogens (Cl, Br, and I) show great hindrance, but two halogen atoms in the ortho-positions are necessary for complete inhibition. (4) The nitro-group exerts the same effect as a halogen atom, and the cyano-group a weaker effect. (5) Acidic groupings show a great hindrance effect. (6) Basic groupings have little effect on the amino-group, but the acetamido-complex exerts an inhibitory action.

FARADAY SOCIETY.

Paper read on October 1, 1926.

Adsorption on Solids with Special Reference to Molecular Orientation. By Dr. W. E. Garner.

Langmuir, in his papers on the properties of the liquid and solid states, has directed attention to the part played by the fine structure of the solid surface in adsorption processes and in the kinetics of heterogeneous reactions. The methods of analysis which he has elaborated for the study of these problems have proved of extraordinary value in accelerating the rate of development of these branches of chemistry and have enlightener us as to the remarkable diversity of the processes which can occur at an interface.

The Solid Surface.—The surface energy of solid substances is distributed among the atoms and molecules composing the surface. It differs from the surface energy of liquids in that it is concentrated at immovable points arranged in a regular pattern across the crystal faces. There has been much discussion as to whether the surface energy be chemical or physical in character. Langmuir, in his summary of the evidence, concludes that both chemical and subsidiary valency forces, *i.e.*, physical forces, are operative in surface phenomena.

The surface forces are but the outward manifestation of those which exist between the atoms and the molecules in the interior of the crystal. Where the atom is the structural basis, as for the elements and most metallic salts, the surface energy is mainly atomic. This energy may be ionic as in the case of metallic salts and possibly of metals, or may take the form of those electromagnetic forces which bind neutral atoms together as in the diamond. The surface atoms of such crystals are unsaturated chemically and readily enter into combination with molecules or ions from the gaseous or liquid phase in juxtaposition with the surface. This process, which is named adsorption, may be accompanied by the evolution of quantities of heat as large as in ordinary chemical reactions. Thus the heat of adsorption of oxygen on charcoal is 68 Cal./g. mol. of oxygen adsorbed and that of hydrogen on nickel 20 Cal./g. mol. The adsorption is often irreversible as for carbon monoxide on tungsten or for oxygen on carbon.

The surfaces of crystals, in which the molecule is the crystal unit and the binding forces are the subsidiary valencies, are less unsaturated than those above and unless the molecules contain unsaturated groups the crystal surfaces possess but a small adsorptive power and catalytic activity. The reaction between ethylene and bromine which occurs readily on the surface of glass takes place very slowly, if at all, on the surface of paraffin wax, which possesses very weak subsidiary valency forces.

Recent work by Maxted, Adams, Pease, Vavon and Husson, Rideal, and others on the poisoning of solid catalysts has shown that only a small portion of the total area of a catalyst is active chemically. These active patches on the surface of the catalyst are very strongly adsorbent and very readily poisoned by strongly adherent substances. The view has been put forward by Taylor that the atoms composing the regions of greatest activity are more unsaturated chemically that those forming the remainder of the surface. It is considered that the variations in the surface forces are caused by differences in the manner in which the atoms are interlinked on the faces, edges and corners of the crystal. The unsaturation may, however, be due to the presence of metastable atoms which possess a relatively high internal energy, especially at temperatures very far removed from the melting-point of the solid.

A striking example of the effect of differences in the mode of linking of atoms in a crystal on the adsorptive power is given by the work of Nallensteyn, who has shown that methylene blue is adsorbed on diamond and not on graphite and that succinic acid is adsorbed on graphite and not on diamond.

Taylor puts forward the view in diagrammatic form that the degree of unsaturation of a surface atom is to be measured by the number of free valencies it possess. This number depends on the number of constraints by which it is attached to the surfaces, edges or corners of the crystal. This idea is open to criticism, at least, in so far as the surface of carbon is concerned. The heats of reaction for the adsorption of oxygen on a carbon surface and for the oxidation of carbon in bulk at room temperature are given below :—

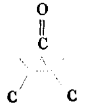
$$2C \text{ (in bulk)} + O_2 = 2CO \text{ (gas)} + 58 \text{ Cal.} \quad \text{I.}$$

$$2C \text{ (in bulk)} + O_2 = 2CO \text{ (surface)} + 68 \text{ Cal.} \quad \text{II.}$$

The heat of desorption of carbon monoxide is given by

$$CO\text{(surface)} = CO \text{ (gas)} - 5 \text{ Cal.} \quad \text{III.}$$

for the activity of the carbon surface returns to its original value after the removal of the carbon monoxide. Equation III. entails the breaking of two carbon-carbon liikinks, thus :—



This is an endothermic process, during which 5 Cal. are absorbed. Since the absorption of 100 Cal. is associated with the breaking of one carbon-carbon linking in the sublimation of the diamond, it would appear to be very unlikely that at the conclusion of reaction III. any appreciable fraction of the surface carbon atoms possessed free valencies. At higher temperatures where the heat of adsorption appears to be greater, the carbon surface becomes more unsaturated and at the sublimation point of carbon, the surface atoms may possess free valencies. Rideal has dealt with the problem in a more general manner and classifies the different types of activity as due to (a) amorphous material, (b) the micro-crystalline edges and corners, and (c) the crystal facets. On this basis he is able to explain the results of Pease on the poisoning of a copper surface by carbon monoxide and mercury. The addition of these substances prevents the hydrogenation of ethylene without appreciably affecting the adsorption of hydrogen and ethylene. Rideal assumes that the active areas for the hydrogenation are the amorphous patches. Langmuir has pointed out that the surfaces of amorphous substances are much more unsaturated than those of crystalline substances and on this account their catalytic effect is probably greater. He quotes as an example the experiments of Bodenstein and Ohlmer on the behaviour of crystalline and glassy quartz as a catalyst for the oxidation of carbon monoxide.

The bearing of the high values obtained for the heat of adsorption of oxygen on charcoal on the activity of surfaces has also been discussed by the author. The areas which give this high value for the heat of adsorption are only 3 per cent. of the total area of the charcoal.

An active surface is the seat of slow changes which tend to destroy its activity. Bone and Andrew find that the activity of a gold surface at 300°, as measured by its power of causing combination between carbon monoxide and oxygen, is very much reduced by cooling the surface to room temperature for a few days. The surface change may be due to structural modifications or possibly to "sub-atomic changes" in the metallic catalyst.

PROCEEDINGS OF THE THIRTEENTH INDIAN SCIENCE CONGRESS. SECTION OF CHEMISTRY.

President—PROF. B. B. DEY, D.Sc., F.I.C.

PRESIDENTIAL ADDRESS.

January, 1926.

(Continued from Last Week.)

"I shall now proceed to consider some of the main lines in which the problems of vital processes particularly in plants are being attacked at the present day, and in which discoveries of fundamental importance are likely to be made in future.

The most logical course appears to be to consider the subject in the sequence in which it has been developing during the past two decades—the steadily advancing knowledge of the reagents elaborated by the living protoplasm and the mechanism of their action, the manner in which the energy of the sunlight is trapped and built into chemical energy for the synthesis of its essential requisites of growth—the proteins and carbohydrates, and finally of the various degradation processes involving the release of the energy locked up in the molecules of these antecedent products.

To a class of men who had early realised the necessity and importance of a proper understanding of the chemical processes taking place in the living organism, but who, by reason of their general indifference to scientific methods, perhaps rightly deserve the epithet of 'quacks,' we are chiefly indebted for the present renaissance in our science—I mean the return of organic chemistry to the main theme from which it departed nearly a century ago. Being better trained in the methods of science, the chemists, or at least some of the best minded of them, quickly perceived the tremendous possibilities of this line of investigation, and it has been mainly through their entrance into the field that the old science of biology is being given an exactitude that had not hitherto been considered possible.

After the long drawn controversies of Bishop Needham and his pupils and their antagonists, the position of the spontaneous generation theory seemed to have neither prospered nor declined when Pasteur published his classical memoirs on bacterial action and sterilisation and showed that fermentations would not occur in media in which all living organisms had been killed by heat. There was thus brought into the ken of accurate scientific investigation the

presence and influence of those myriads of animalcules with their diverse functions which were the responsible agents in bringing about the transformations in plants and animals. It is not my purpose, even if I had the qualification to do so ,to trace the development of the technique of researches which culminated in the opening of such altogether new branches of science as bacteriology or micrology, but I merely wish to draw your attention to the most significant change in the angle of vision that was effected through these discoveries and improved methods of experimentation. The more intensive study of the changes occurring in Nature which followed these researches, and which received a great impetus from the remarkable results obtained at about the same time by Fischer regarding the composition and structure of many of the complex bodies of living tissue, led to the knowledge, firstly that these biochemical transformations were not so complicated as they had been imagined to be at the beginning, but were of the same order as the simple hydrolytic and oxidative changes involving the rupture of the carbon chains, secondly, that they could be produced in the laboratory with the aid of freshly prepared extracts of animal or vegetable tissues, and lastly, that these had properties fundamentally similar to those of many of the inorganic catalysts with which chemists had long been familiar. The suggestion thus became inevitable that most, if not all of the reactions associated with the living cell could be realised in the laboratory with the aid of the lifeless products of these cells; the conclusive proof of this, however, was not forthcoming until the close of the last century when Buchner gave his experimental demonstration of the fact that the juice obtained from ruptured yeast cells prepared with such precautions as ensured the complete absence of living cells, still retained unimpaired its power of converting sugar into alcohol. The most important consequences of this discovery was the universal recognition that the process of fermentation did not require the cooperation of the living plant but only its agents, we now call the enzymes, which are capable of bringing about the observed chemical changes even after the death of the organism or separation from the cell in which they were manufactured. The further study of these agents, their distribution, classification, mechanism of action etc., has attracted so many worers and led to developments in so many directions that it would hardly be an exaggeration to say that modern Biochemistry has become virtually synonymous with the chemistry of these bodies. The answer to the fundamental question what is an enzyme is still however incomplete, and will probably remain so, as long as we are unable to isolate the enzyme itself and have to rely on the device of proving its presence from the occurrence of the reactions which it brings about. Enzymes are stated to have been prepared in solution (—) this is obviously incorrect in the light of modern views of enzyme action taking place essentially at solid surfaces and not in solution—as well as in the solid condition, but they have usually been obtained in a highly impure state, the reagents like alcohol, acetone, etc., which are used for their precipitation, serving also to throw out of solution such substances as the proteins or the carbohydrates which invariably accompany them in the tissue fluids. This is no doubt largely responsible for much of the conflicting evidence one comes across in current literature regarding the chemical nature of the enzymes which are regarded as proteins themselves, or compounds of proteins and carbohydrates or even as adsorption complexes of an active principle like a Vitamin or a Hormone with a nitrogenous colloid. A mass atack on the chemistry of some of the common enzymes like Invertase, Maltase, Emulsin, and others has been recently commenced by Willstatter as a first step to the complete overhauling of the subject, and it may be hoped, in view of the brilliant successes of this investigator in other fields of plant chemistry, that further information on the subject would be available in the near future.

While the enzyme still eludes our grasp, the persistent efforts of the chemists to straighten out the tangle have however borne fruit in other directions. Many of our modern ideas regarding the properties of those large aggregates of giant molecules —the colloidal systems, our notions of the great extension of surface area in these bodies, the remarkable concentration changes due to surface action conveniently grouped under the name of 'adsorption,' the influence of hydrogen ion concentration of the media on the colloid particles and their behaviour at the iso-electric point, the theories of membrane equilibrium of Donnan and Loeb, etc., are some of the numerous developments in this field which may be traced directly or indirectly to this source. The importance of these results,

morever, can hardly be over-estimated, affording as they do a valuable clue to the great variety of chemical actions that take pace at the surfaces forming the cell walls in the living organism.

Whether the chemist will ever succeed in doing away with the vital origin of the enzyme by synthesising it in the laboratory, it is not possible to state with any assurance now, but of considerable interest from this point of view is Dony-Henaults' preparation of an artificial 'laccase' by the precipitation with alcohol of a solution containing gum arabic (10 grams), manganese formate (1 gram), and sodium bicarbonate (4 grams) in water (50 c.c.). This substance, which is undoubtedly a colloidal complex containing manganese hydroxide, has been found to have the properties of Bertrand's 'laccase' and to be of almost the same degree of activity. The function of the gum appears to be that of a stable colloid which keeps the manganese hydroxide in a permanent highly divided condition so as to maintain a large active surface. The question naturally arises, therefore, as to whether enzymes, too, are not made up of similar systems—a suggestion which derives considerable support from the observation that the ashes of almost all enzymes contain an inorganic residue. The nearest approximation to this conception has been attained in the case of those interesting groups of substances called oxidases which play such an important role in plant and animal life. These bodies have now turned out not to be just simple enzymes but a complex system consisting of at least two constituents—an autoxidisable substance capable of forming a peroxide with molecular oxygen and an enzyme called a 'peroxidase' which accelerates the decomposition of the peroxide and liberates atomic oxygen which is the primary oxidising agent of the cell.

A clearer illustration perhaps of this idea would be afforded by the following example: If a mixture of lactic acid and hydrogen peroxide be taken, it is found that oxidation proceeds with extreme slowness, whilst the addition of a minute quantity of ferrous sulphate accelerates the oxidation beyond all proportions. If, now, instead of the iron salt the peroxidate, say of the horse-radish plant, be added, the reaction is found to be accelerated in precisely the same manner. The conclusion has therefore been drawn by Perrin and others that an oxidase is the combination of a hydrosol of ferric or manganic hydroxide with a hydrophile colloid. Willstätter and Pollinger who have recently studied this question very carefully have pointed out, however, that although no oxidase preparations could be made entirely devoid of iron, the content of the metal was in no way proportional to their activities."

(To be Continued.)

FORTHCOMING EVENTS.

BIRKBECK COLLEGE.

(University of London). Breams Buildings, Fetter Lane, London, E.C.4.

A free Public Lecture on "University Education in the United States will be delivered by Dr. Edwin Deller, LL.D., Academic Registrar of the University, on Monday, November 15, 1926, at 5.30 p.m. The chair will be taken by Sir William H. Beveridge, K.C.B., LL.D., Vice-Chancellor of the University.

ROYAL INSTITUTION OF GREAT BRITAIN.

21, Albemarle Street, Piccadilly, W.1.

Saturday, November 13, 1926.—Rev. E. M. Walker, D.D., LL.D., "Study of History: Its Method. (Lecture II.)

Validity of the distinction between Objective and Subjective History.

The new kinds of evidence available to the historian at the present day. In Ancient History, Archæology and Papyrology; in Mediæval and Modern History, the treasures of the Record Office or unpublished correspondence.

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In Ancient History the cumulative effect of the discoveries is to confirm tradition. The scepticism of the Nineteenth Century scholars is largely riscredited.

ROYAL SOCIETY OF ARTS.

Friday, November 12, at 4.30 p.m.—(Indian Section.) Sir ames B. Brunyate, K.C.S.I., C.I.E., "The Report of the Indian Currency Commission." Frederick Craufurd Goodenough, Member of the Council of India and Chairman of Barclays Bank, Ltd., widd preside.

Monday, November 15, at 8 p.m.—(Howard Lecture.) Professor Hugh L. Callender, C.B.T., M.A., F.R.S., "Recent

Experiments on the Properties of Steam at High Pressure." (Lecture I.)

Wednesday, November 17, at 8 p.m. (Ordinary Meetinng.) Thomas Brough, J.P., Chief Designer, Messrs. Courtauld's Ltd., "Artificial Silk." S. A. Courtauld will preside.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.

Tuesday, December 14, at 5.30 p.m., at the House of the Royal Society of Arts, John Street, Adelphi, London.

INSTITUTION OF ELECTRICAL ENGINEERS.

Savoy Place, Victoria Embankment, W.C.2.

Thursday, November 18, at 6 p.m.—Dr. A. Ekstrom, Lecture on the "Application of Electricity to Agriculture" (Illustrated).

. W. Beauchamp, Exhibition of a film, entitled, "American Agriculture and Farm-House Electrification."

SOCIETY OF CHEMICAL INDUSTRY.

The annual dinner will be held at the Connaught Rooms, Great Queen Street, London, on Friday, November 12, at 7.30 p.m. Professor Doaana will preside. Some ten associate Societies are participating in this important function.

THE NORMAN LOCKYER LECTURE, 1926.

This lecture will be given in the Goldsmiths' Hall (by kind permission of the Goldsmiths' Company), on Tuesday, November 23 next, at 4 p.m. The Lecturer will be Professor J. S. Huxley, M.A., Professor of Zoology and Animal Biology at King's College, who will speak on "Biology and Human Life." Tickets for the Lecture may be obtained on application to the Secretary, British Science Guild, 6, John Street, Adelphi, London, W.C.2.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

At a meeting held on November 4, the Council of the Institution of Electrical Engineers unanimously elected Senatore G. Marconi, G.C.V.O., LL.D., D.Sc., an Honorary Member of the Institution.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

26,415.—Davies, A.—Manufacture of chemical dispersion agents. Oct. 22nd.

26,053.—Haworth, W. N., and Nelson, Ltd., J.—Method of concentrating aqueous solutions of acetic, etc., acid. October 19th.

26,332.—Hummerich, F., and Maennchen, K. F.—Production of preparations of dyestuffs. October 21st.

26,298.—Kekwick, L. O.—Production of hydrocarbons. October 21st.

25,945.—Mannish, C.—Manufacture of dicyclic derivatives of pentamethylene. October 18th.

Specification Published.

259,631.—Desborough, A. P. H., Thaysen, A. C., and Green, B. M.—Fermentation processes for the production of a-butyl alcohol and acetone.

259,641.—Dreyfus, H.—Manufacture of acetic acid.

259,643.—Cicali, G.—Production of hydrogen practically free from carbon monoxide, starting from water-gas or the like.

287,257.—Chmura, T.—Process and apparatus for de-oxygenating air by the combustion of sulphur o: its incompletely ovidised compounds.

259,704.—Damiens, A. A. L. J.—Process for separating carbon monoxide from industrial gases.

Printed Copies of the full Published Specification may be obtained from the Patent Office, 25 ,Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

Abstract Published.

/257,528.—Pigments.—I. G. Farbenindustrie Akt.-Ges, Frankfort-on-Main, Germany.

Lakes.— In a process such as that described in Specification 181,584 for the production of green pigment colours by treat-

ing α-nitroso-β-naphthol or its bisulphite compound with ferric or ferrous oxide in the presence or absence of substrates, the colours are prepared in the presence of basic dyestuffs preferably of the malachite green series, which influences the shade while retaining or increasing their fastness to light and alkalis. The iron salt may be used in theoretical or les squantity as described in Specification 181,584 or in larger amounts and in the presence or absence of Turkey red oil or other dispersing agents, the basic dyestuff being added to the mixture. The pigment colour is precipitated with sodium carbonate, and preferably, a small quantity of the carbonate, insufficient to cause precipitation, is added before the basic dyestuff. In an example, diamond green BX is employed as the basic dyestuff and after precipitation of the colour a small quantity of aluminium hydroxide paste is added.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

"BICETIC."

472,184.—Chemical substances used in manufactures, photography or philosophical research and anti-corrosives.—William Frederick Sadler, 8, 9 and 10, Great St. Helen's London, E.C.3. October 27th.

PERMINAL.

472,608.—Chemical substances used in manufactures, photography or philosophical research, and anti-corrosives.—British Dyestuffs Corporation, Ltd., 70, Spring Gardens, Manchester. October 27th.

HAWK-EYE.

472,815.—Photographic chemicals, plates and films (sensitised). — Kodak, Ltd., Kodak House, Kingsway, London, W.C.2. October 27th.

TASHALINE.

471,353.—Chemical substances prepared for use in medicine and pharmacy.—Laboratorium "Tasch" Aktiengesellschaft, Garteustrasse, 1, Allschwill, near Basle, Switzerland. October 27th.

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THE STRUCTURE OF BORON.

By HAWKSWORTH COLLINS, B.A.(Camb.).

As there are comparatively few compounds containing boron, it is possible to place the whole matter concerning the structure of this element before scientists in a short paper without the absolute necessity of referring to other papers.

(1) The atomic weight of B is 11, and its valency is 3, so that it satisfies the Odd and Even Rule, which was first published in the *Chemical News*, 1907, XCVI., 176, as follows:—"When the atomic weight of an element is odd, its valency is odd, and when its at. wt. is even its valency is even." This is a rule, not a law, and therefore may have one or two exceptions.

(2) The number 11 can be split up into three parts, 7 + 1 + 3, from each of which (representing lithium, hydrogen and H_3 respectively) a single valence is known to emanate. This accounts for the element being a triad.

(3) Hydrogen forms the connecting link in the structure of the simple elements. This matter was first demonstrated in the *Chemical News*, 1914, CIX., 26. It can be best demonstrated by an additional example, *e.g.*, Cr = Na + H + Na + H + H_3 + H. This is a hexad and from each of the six parts it is known that one valence emanates.

(4) Boron is monobasic and *diacidic*; *i.e.*, it is a non-metal, and therefore must contain a free helium-portion, H + H_3. This fact was first published as a law in an advertisement in the periodical *Nature*, in 1906, in the following words:—"The non-metallic nature of an element is always due to a pair or pairs of electro-positive forces, each pair emanating from a portion of the element of which the mass is 4, taking the mass of an atom of hydrogen as unity." The full exposition of this law, including the discovery of H_3, was sent to Prof. Soddy and Sir J. J. Thomson and others in 1906. In 1912 the former confirmed the law, which concerned the commonest elements, by experimental observations upon the rare elements; and the latter discovered experimentally in 1913 the existence of monadic H_3 which had previously been shown to be an important constituent of the simple elements.

The above structure for boron will now be proved to be true by means of two independent series of experimental data, Specific Gravity and Heat of Formation, neither of which was originally employed in the discovery of its structure.

Table I.

The Relative Volumes of Boron.

	B	=	Li	+	H	+	H_3
(5)	2.9	=	0	+	0	+	3(0.96625)
(6)	3.865	=	0	+	0.96625	+	3(0.96625)
(7)	15.73	=	11.865	+	0.96625	+	3(0.96625)
(8)	14.76	=	11.865	+	0	+	3(0.96625)
(9)	11.865	=	11.865	+	0	+	0

0.96625 has previously only been given to two decimal places as 0.97.

Table II.

Experimental Data Illustrating Table I.

	Relative Volumes.	Theor. S.G. at 15° C.	Obs. S.G.	
(10)	MnB_2 6.94 + 2(2.9)	6.04	6.04	19° Nostrand
(11)	MnSi 6.94 + 7.13	5.90	5.90	15 Nostrand
(12)	$MnSi_2$ 6.94 + 2(7.13)	5.24	5.24	13° Nostrand
(13)	NiB 6.57 + 2.9	7.39	7.39	18° Nostrand
(14)	Ni_2P 2(6.57) + 10.51	6.3	6.3	15° Nostrand
(15)	FeB 6.4 + 2.9	7.20	7.15	18° Nostrand
(16)	$FeSi_2$ 6.4 + 2(7.13)	5.4	5.4	Pick & Conrad
(17)	SrB_6 23.98 + 6.(3.865)	3.27	3.28	15° Nostrand
(18)	SrC_2 23.98 + 2(5.69)	3.17	3.19	Nostrand
(19)	SiC 7.13 + 5.69	3.12	3.12	15° Nostrand
(20)	CB_6 8.0 + 6(3.865)	2.50	2.51	Nostrand
	(C has frequently been shown to have the vol. 8 in carbonates.)			
(21)	KBF_4 22.29 + 3.865 + 4(5.42)	2.6	2.6	Stolba
(22)	B_2O_3 2(15.73) + 3(2.51)	1.80	1.803	Davy
(23)	B_2S_5 2(15.73) + 3(15.53) + 2(10.51)	1.84	1.85	Nostrand
(24)	BCl_3 15.73 + 3(23.01)	1.39	1.35	Wohler
			1.434	0° Nostrand
(25)	H_3BO_3 3(5.76) + 15.73 + 3(2.51)	1.53	1.52	12° Ditte
(26)	Triethyl borate 3(48.09) + 15.73 + 3(2.51)	0.8716	0.871	Bowman
(27)	Tripropyl borate 3(48.09 + 16.42) + 15.73 + 3(2.51)	0.867	0.867	16° Cahours
(28)	Diethyl amyl borate 3(48.09 + 16.42) + 15.73 + 3(2.51)	0.867	0.858	26° Schiff
			i.e. 0.864 15°	
	where amyl is 48.09 + 3(16.42), 16.42 being the vol. of each added CH_2.			
(29)	Ethyl diamyl borate 3(48.09) + 6(16.42) + 15.73 + 3(2.51)	0.8646	0.876	0° Schiff
			0.852	28° Schiff
			i.e., 0.864 15°	
(30)	Triamyl borate 3(48.09) + 9(16.42) + 15.73 + 3(2.51)	0.86	0.872	0° Schiff
			0.852	24° Schiff
			i.e. 0.86 15°	
(31)	$Na_2B_4O_7$ 2(11.85) + 2(15.73 + 3.865) + 7.53 + 6(2.51)	2.364	2.367	Filhol
(32)	$Na_2B_4O_7.10H_2O$ same + 10(14.03)	1.6926	1.692	Filhol
			1.692	Buignet
(33)	When 7.53 becomes 4.45 in the last the theor. S.G. becomes	1.716	1.716	Mohs
(34)	When 7.53 becomes 2.51 in the same the theor. S.G. becomes	1.731	1.730	Playfair
			1.736	W. C. Smith

TABLE III.

	Heat of Formation of Boron.	Orig. Vol.		Rel. Vol. in combination at 15° C.		Change of Volume
(35)	$-8450 = 795 \times (-0.96625) \times 11$	2.9	=	3.865	-	0.96625
(36)	$-8450 = 795 \times (-0.96625) \times 11$	14.76	=	15.73	-	0.96625
(37)	$69960 = 795 \times 8.0 \times 11$	11.865	=	3.865	+	8.0
(38)	$-33799 = 795 \times (-3.865) \times 11$	11.865	=	15.73		3.865

TABLE IV.

EXPERIMENTAL DATA ILLUSTRATING TABLE III.

	Heat of Formation .	Theor.	Obs.
(39)	$B_2.O_3$ - 2(8450) + 3(96155) (corresponds with No. 22)	= 271565	272600
(40)	$B_2.S_3$ - 2(8450) + 3(30681) (corresponds with part of No. 23)	= 75143	75800
(41)	$Na_2.B_4.O_7$ 2(32706) + 2(69960) - 2(33799) + 32341 + 6(96155) (corresponds with No. 31)	= 747005	748100

In Table I. the five volumes are shown to be compounded, in different ways, of only two parts, 11.865 and 0.96625; and each one of the five cases strengthens the Law of Relative Volume, which has been demonstrated in about thirty preceding papers in the *Chemical News*. The law is as follows—

"The relative volume of an element is the sum of the relative volumes of its parts, any one or more of which may be zero."

When a part-volume is zero, this portion has been absorbed by the remainder of the element without altering the volume of this remainder, only changing its density.

Three of the volumes are demonstrated in Table II. by means of Specific Gravity. The other two are shown to be required in Table III. by the Law of Heat of Formation, which has also been demonstrated fully in the thirty preceding papers.

Table III. shows the manner in which all the five volumes are connected by the law of H.F.; and Table IV. interprets experimental results showing that the values of H.F. given in Table III. are correct.

The whole constitutes a proof that the structure of boron has been correctly obtained.

It is quite evident that no one could possibly have guessed these results and then made the experimental facts fit in with his hypothesis. The only way by which this intricate interdependence of results could have been discovered is by correct reasoning upon experimental facts.

There is plainly a great difficulty in the experimental determination of the S.G. of boron as a free element. There seem to be only two experimental determinations of this S.G.; one is 2.68 by Wohler about 60 years ago, and the other is 2.554 18° given in Van Nostrand's Annual, without any statement as to who obtained the results. Both values are probably wrong.

THE SEARCH FOR THE ELEMENT OF ATOMIC NUMBER 61.

By PROFESSOR W. PRANDTL.

[EDITORIAL NOTE.—At the suggestion of F. H. Loring, Esq., we are publishing abstract translations of two recent papers in the *Zeitschr. f. angew. Chemie*, by Professor Prandtl (the second in collaboration with Dr. Grimm) on his experiments in search of the missing element of atomic number 61. It will be recalled that the papers by J. Allen Harris, B. Smith Hopkins and L. Yntema appeared in the *Journal of the American Chemical Society* (1926, XLVIII., 1585, 1594—June).

During the last sixty years the *Chemical News* has published so many important discoveries, including those connected with the discovery of new elements, that its readers will be particularly interested in these English renderings of Professor Prandtl's work.]

Professor B. S. Hopkins, J. A. Harris and Dr. L. Yntema announced in March last that they had discovered the long-sought element of atomic number 61. As I have sought for this element fruitlessly for years (see Z. *anorg. Chemie*, 1924, CXXXVI., 238), I am in a position to examine their work critically.

The claim to the discovery of element 61 rests on the following facts :—

(1) In the arc spectrum of pure Nd and Sa oxides there are about 130 lines belonging to no known element.

(2) By fractionation of Nd—Sa bromates in mixtures the middle fraction shows an absorption band at 5810 A—"where that for 61 should appear."

(3) Two X-ray plates show a weak but distinct line attributed to the $L\alpha_1$ of 61. Its wave-length differs from Siegbahn's calculated value for 61 by + 30 to + 40 ten-thousandths of an A unit.

Using preparations from B. S. Hopkins, Kiess surveyed (U.S. Bureau of Standards, 1922, XVIII., 201, 211, 219) the arc spectra of Nd and Sa which are extraordinarily rich in lines. He recorded about 1,500 lines for each element and also found in each an additional 130 weak lines (two had an intensity 5, 14 had intensity 3, all others were weaker still). He observed that it is not definite whether they are actually belonging to both elements or are due to an impurity (*e.g.*, a new element). In the X-ray spectrum of these preparations Yntema found (*J. Amer. Chem. Soc.*, 1924, XLVI., 37) no indications of the existence of 61. In my opinion the weak arc lines give little support to the argument. The large number of common lines in the arc spectrum of these two elements is well known. These arc spectra must be interpreted with caution. It will be recalled that Exner and Hatschek (*Sitzber. Wiener Akad.*, 1910, CXIX., 771) concluded from a comparison of the arc spectra of Gadolinium, Terbium, Dysprosium, Holmium, Erbium, Thulium, Ytterbium, and Cassiopeium that other elements were present which have not been isolated. Indeed they supposed at least five intermediate bodies to exist and termed them E, Δ, D, α and X.

They also gave the lines characteristic of these "elements."

Eder and Auer von Welsbach also concluded (*Sitzber. Wiener Akad.*, 1915, CXXIV., 747) from a study of the arc spectra of Erbium-Thulium-Ytterbium fractions that the Tm component contained two unrecognised elements which they termed Denebium and Dubhium. X-ray work has shown since that there is no place for these new elements.

Concerning (2), whilst Hopkins and his co-workers fractionated Nd-Sa bromates, I crystallised the double magnesium nitrates. The intense absorption spectrum of Nd. is in the yellow (between 5700 and 5900). It appears as a broad black band in concentrated solutions, but in dilute solutions there are at least four narrow bands of different width and intensity. As Hopkins and his co-workers have observed, by continued fractionation of Nd Sa salt mixtures the position and the intensity of these four narrow bands interferes considerably with the absorption spectrum of an equally strongly absorbing solution of pure Nd nitrate the richer it is in Sa and the poorer it is in Nd.

I was not able to make accurate measurements of this influence but I had hoped to concentrate element 61 by this process. But it happens that the position and intensity of the absorption regions of the rare earth salts can vary with the concentration. Thus I have shown that the absorption spectrum of Nd is altered by a concentrated samarium nitrate solution. Therefore the changes observed by Hopkins in the absorption of Nd-Sa fractions are no indication of the presence of 61. Neither is it possible to predict what such a spectrum should be like.

(3) The data concerning the weak X-ray line attributed to 61 $L\alpha_1$ is not clear. What does it mean that the line agrees within +3 and −4 units with the calculated value? If the line indicated anything it must at least correspond within 1 X unit with the calculated value. It is also important to know what other lines occur on the plate.

In the series Nd—61—Sa the solubility of the bromates falls with increasing weight, but that of the double magnesium nitrates rises. On fractionating the bromates 61 is in the least soluble end fraction, when fractionating the salts with $Mg(NO_3)_2$ it is in the final liquor. In my opinion the second method is best. Basicity also falls in this series with increasing atomic weight so by precipitating with weak bases 61 can be enriched with Sa.

Concerning the absorption spectrum the Americans state : "Two bands, one at 5816 A. U., and another at 5123 A.U., that had shown very faintly in supposedly pure Nd., became stronger in some fractions as the Nd. bands disappeared." Both bands belong to the strong wide absorption region 5350-5000, and would appear as the solution was diluted. Dr. Grimm has found no X-ray evidence in favour of the presence of 61 although his spectrograph could detect .01 per cent. of an admixture of it in the fractions examined. Concerning their X-ray analysis, Harris, Yntema and Hop-

kins state :" A mean value of five determinations of 2.2781 A.U. was found for the $L\alpha_1$ line and one determination of 2.0770 A.U. for the $L\beta_1$ line. A faint indication of the $L\beta_3$ line was also noted."

They should have stated what their dispersion was and what were the main lines on the plate and what was the ratio of the intensities. If the $L\alpha_1$ line was so weak that its position was recorded as the mean of five readings the position of the β line can hardly be established from one measurement.

(Condensed translation from the *Zeitschrift für angewandte Chemie*, 1926. XXXIX, 897).

PROCEEDINGS OF THE THIRTEENTH INDIAN SCIENCE CONGRESS. SECTION OF CHEMISTRY.

President—PROF. B. B. DEY, D.Sc., F.I.C.

PRESIDENTIAL ADDRESS.

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(Continued from Last Week.)

In connection with the nature of the second constituent, the newly discovered glutathione, an autoxidisable substance of a special type, should call for some attention. It is a dipeptide of cysteine and glutamic acid, which has been found to be widely distributed in animal tissues and also in yeast cells though in only small quantities (.01 to .02%), and is intimately concerned in the oxidation processes of the cell. It owes its importance as a catalyst to the fact that its thiol or sulphydryl groups are readily attacked by molecular oxygen with the formation of a disulphide compound of the type of cystine, which is rapidly reduced back to the thiol form agaiu, the tissues themselves supplying the necessary hydrogen atoms and thereby becoming oxidised.

The power of the cell to bring about these changes spontaneously has been clearly demonstrated by Hopkins who allowed fresh tissue to autolyse with glutathion under anaerobic and aseptic conditions and showed that while oxidation rapidly took place in a neutral or faintly alkaline medium (PH, 7.4) as seen by the discolorisation of methylene blue if the experiment was carried out in its presence, the reverse change *i.e.* the reduction of disulphide as readily occurred when the medium was rendered faintly acid (PH, 6.8). There can be little doubt, therefore, that glutathione and similar other autoxidisable bodies, still undiscovered, afford in the tissues a mechanism capable of accepting either hydrogen or oxygen and thus promoting processes of oxidation and reduction which would not occur in their absence. The existence of this dipeptide rather than that of cysteine itself in the tissues has been attributed to the fact that it oxidises more slowly than cysteine, and thus offers the necessary resistance to metabolic changes.

I might at this point make a passing reference to the long known but hitherto little understood problem of the specificity of an enzyme—its partiality for certain definite substances on which alone it will react leaving other bodies untouched. The large amount of evidence that has been accumulating on the subject has at least helped to throw light upon the remarkable manner in which an enzyme really acts. The true significance of the old simile that the enzyme must needs be adapted to the substance on which it is to act—the substrate as it is termed—just as a key must be adapted to the lock wheh it is to open, is being realised from the recent picture of the enzyme as drawn by Armstrong—an 'aggregate of complex organic substances possessing an elaborate structure and containing a variety of radicles. The molecules are oriented at the large active surface of the colloid aggregate in such a way that certain groups are exposed and highly active whilst others are directed away and rendered inoperative, thus endowing the enzyme molecules with selective powers of so fine a character as almost to merit the description of intelligence.' Specificity implies, therefore, nothing more than that peculiar interdependence—and not likeness as sometimes erroneously stated—between the architecture of the enzyme molecule or its active part and that of the substrate which gives it the power to anchor or lodge on the latter. It needs no great stretch of imagination to perceive that only substances of a definate structure could fit in or associate with the surface, whilst a slight variation in this, or in that of the enzyme colloid would prevent all action.

Coming to the consideration of the other explanations that have been advanced from time to time of the selective action of an enzyme, I might mention the interesting, though still inadequately appreciated theory of Collie, as it offers rather a unique interpretation of the reactions of sugar fermentations. Collie compares the molecule of a sugar to an electrolysing system as will be

apparent from an examination of the structural formula of, say, an aldohexose in its hydrate form.

If we now imagine a pair of terminals inserted in the molecule, the hydrogen atoms would be drawn to one side—the left, whilst the hydroxyl groups would move to the right. This would give us the same accumulation of hydrogen atoms at one end and hydroxyl groups at the other which is so well adapted to the chemical representation of the course of sugar fermentations. If we are further permitted to picture the enzyme as inserting the electrical terminus into the molecule of the sugar, not necessarily at the two ends of the chain but at any point in the molecular structure which is spatially suited to their entry, we might be able to account perhaps for the selective action of different enzymes.

Notwithstanding all that has been said, however, the precise manner in which an enzyme performs its function of accelerating a chemical change still remains a mystery. We may imagine the enzyme molecule undergoing temporarily some subtle change in configuration, thereby imparting a shock to the substrate the consequence of which is manifested in the chemical change of the substrate. Such a conception recalls the old view of Liebig that the changes brought about by micro-organisms were due to molecular vibrations which were set up by the living protoplasm and which were of sufficient strength to shatter the molecules of non-living materials which came in its vicinity. In fact, problems like these compel us for the time being to fall back upon the old idea of some subtle, though not perhaps transcendental, agency operating in nature which we have not succeeded in fully fathoming yet. Admitting, however, this picture of the enzyme molecule oscillating between the different configurations, the action may be supposed to continue until the substrate has been decomposed or the character of the environment has altered to such an extent by virtue of the elaboration of the products of its activity, that it will have either lost its power of lodging on the substrate, or its activity will be completely inhibited. The peculiar sensitiveness of an enzyme to its environment has long been known, and enables us to understand the great importance of PH values of tissue fluids in plants and animals. Since all enzyme reactions are of the nature of hydrolyses or of additions or withdrawals of hydrogen ions, the existence of an intimate connection between the concentration of this ion in the liquids and the action of the enzymes should only be anticipated. They represent a condition of the menstruum favourable or inimical to the necessary transformations of the enzymes.

The various other factors affecting enzyme action such as the influence of temperature, concentration of metallions, etc., or the action of the various co-ferments and anti-ferments constituting a protective mechanism for plant or animal tissues, which have been brought to light in recent years, would no doubt supply themes of surpassing interest, but it is hardly possible to discuss them here. I would only take this opportunity of drawing your attention to what appears to be an interesting parallel between the 'anchoring' idea of enzyme action mentioned above and the underlying principles of Chemo-therapy—*i.e.*, the treatment of infections in animals by chemical specifics. Whilst there still remain many apparently irreconcilable facts in this extremely promising field of research, the outstanding feature of Ehrlich's theory, namely, the selective action of chemical specifics—dyes like Afridol-Violet, Baeyer 205, Fourneau 309, etc., or the now familiar organic compounds of arsenic, antimony, mercury, etc., which react upon the protoplasms of parasites without injuring those of the host seems, in its simplest form of statement, not to differ very materially from the conception of the specificity of enzyme action on which so much stress has been laid. It may be incidentally observed that the two dyes, both derived from benzidine, which have hitherto had a genuine success in the treatment of diseases of protozoal infection, are Trypan Red discovered by Ehrlich and Shiga, and Trypan Blue prepared by Mesnil and Nicolle, and it was with the aid of these, and through the development of the technique in the hands of Laveran and Mesnil by which a particular strain of trypanosomes could be passed through a series of mice and other animals of the same species so as to produce an infection of standardised type and virulence, that it has now been possible to show that the original theory on which Ehrlich proceeded was not sufficient, the chief disagreement lying in the inability of the dye to kill the same parasite when occurring in different animals. We seem thus to be confronted once more with the same problem of medium or environment the importance of which must be recognised in all our attempts

at initiating any changes in living tissues. Such influence of the medium in activating or paralysing the enzyme has been repeatedly encountered before, and serves to bring out more clearly the analogy subsisting between the two types of action—the action of the enzyme on the substrate, and that of the chemical specific in protozoal infection. The great importance of the role played by the medium, whether in the plant or in the animal, is thus just dawning upon our intelligence; we are beginning now to perceive that onr attempts at copying nature and combating her by her own instruments can never be completely successful until we are able to control the environment, or at least to secure an identity of conditions—a task which seems to be beyond human powers at present.

Whilst the complete solution of the enzyme problem still remains at a distance, the knowledge gained in the past has been of undoubted value n providing us with some good working hypotheses for gaining further insight into the working of the vital machine. It is true that there are many imperfections still gathering round these hypotheses, and facts hard to reconcile with them, hut a little consideration will serve to show that most of these have proceeded from our routine habits of thought and old world conceptions of chemical reactions based upon representation by equations which aim at giving finality to a process, rather than indicating the various possibilities of a balanced reaction. Such an outlook has obviously arisen from the limitations of our experimental vessels which are so fundamentally different from those employed by the living organism. The apparatus of Nature is made out of cellulose with semi-permeable walls immersed in a diversity of solutions differing in nature and concentration from solutions inside, and serving at once as containers, filters, and concentrators. Here, then, is the possibility of infinite gradations of reaction to which we have no laboratory parallel, and the result frequently is the appearance of products scarcely anticipated by our finite chemical equations. Yet the laws of mechanics are never failing and apply with as much force to these unexpected ' averagings ' of Nature as to our ordinary laboratory reactions. The absorption of energy for a particular synthesis and its liberation on the breakdown of the complex molecule are always the preponderating factors, and should be perfectly equatable, if I may use such an expression. The fact that we can rarely draw up an exact energy balance sheet in the case of the complex changes of the living world is due to our ignorance of the course of these changes rather than to any departure from the usual laws governing such changes in the reactions of the living cell.

It is now generally agreed that the conversion of CO_2 and water into formaldehyde which contains the trapped energy of the sunlight, marks the first step in the building up of all vital products—thereaction *par excellence* ' which forms the true key industry of all life."

I cannot help digressing a little and referring in this connection to the philosophical aspects of this photo-synthesis which were first emphasised upon by that daring and brilliant thinker, the late Benjamin Moore. While confirming and extending the results of Bach, Euler, Priestley and others, Moore proceeded further, and attempted to supply some stages that lie between anything ever so simple as the unicellular alga and the inorganic world. Tracing the origin of colloids to a state when Nature could not huild up any more complex molecules, he asserts that ' it was in the sea and in the lakes that life first originated by the bearing down of the sun's energy upon the inorganic colloidal complexities that were beginning to form there. These inorganic colloids not only form the organic matter but they build up into their own cells—they form skeletons for it. And so we can trace, if we commence at these beginnings, how Life began.' Indeed, the difference between the organic and the inorganic worlds is by no means so fundamental as might at first appear. Even the forms of many of the smaller organisms—diatoms and radiolaria and some of the amoeba, betray a striking resemblance to many of the artificially, prepared natural silicates, and the new science of plasmology having for its object the study of the relation of mineral forms to the forms of living organisms, seems to have arrived at the conclusion that the form and strncture of living things are largely due to the interplay of physical and chemical forces such as obtain in the inorganic world. Very significant, therefore, is the remark made by Moore that we shall never trace the beginning of life by studying bacteria, as these would not exist in the new world, having nothing to live upon. Moreover, sunlight is germicidal to bacteria, and hence various colour screens like chlorophyll, etc.,

had to be elaborated for protecting this dawning of life from being killed by the very sunlight which first originated it.

The synthesis of the proteins and even the enzymes and chlorophyll itself, perhaps, is of no less interest from this point of view. A plausible claim has been made out lately by Lipman and Taylor for the direct fixation of nitrogen from the air by the leaves of green plants; even if this were possible, it must occur to only a very limited extent, and we are therefore forced to consider the roots as the primary agents in nitrogen assimilation in plants, and the nitrates as the chief source of this element. The observation was made nearly forty years ago by the botanist Schimper that nitrites are always present in the living green leaf in the dark, but disappear in the presence of sunlight. That nitrates may be reduced to nitrites under conditions obtaining in plant tissues, particularly in the presence of a catalyst like iron ,has now been definitely proved, and Baudisch made the very important discovery that a dilute aqueous solution of potassium nitrite containing methyl alcohol, when exposed to ultra-violet light, yielded small amounts of a highly reactive body identified with formhydroxamic acid.

Combining these observations, Baly has developed his elaborate scheme, familiar to many of you, and supported to some extent by the remarkable experimental proofs adduced by him, in which the great variety of complex nitrogenous bodies actually found in the living plant are traced to the initial interaction between a nitrite and formaldehyde. The molecules of formhydroxamic acid so produced, as well as the formaldehyde, being supposed to be extraordinarily reactive when freshly synthesised, instantaneously react among themselves giving on the one hand α-amino-acids, and on the other, such nitrogen bases as pyrrols, glyoxalins and pyridines, which by further condensation give indoles, quinolines, isoquinolines and xanthine bases.

The recent observations regarding the occurrence of asparagine in plants and its probable function in the translocation of nitrogen from the lear to other parts, and in protein metabolism in general, seem also to be of particular interest in this connection. The diminution of the protein contents of leaves, accompanied by the appearance of increased quantities of asparagin elsewhere in the plant noticed by several workers, has led to the suggestion that this substance acts as a temporary reserve for ammonia or amino-acids in a harmless and mobile condition suitable for transport from one part of the plant to another. The asparagin probably acts by regenerating ammonia which condenses with the α-hydroxy, of keto-acids obtained from the carbohydrates by enzymatic activity to form amino-acids, and thence, through the normal stages stages of polypeptides and proteoses, the moecule of the protein itself. This view of the function of the asparagin in the plant thus assigns to it a role which would seem to be somewhat similar to that of urea in the animal. The ammonia of protein metabolism, being toxic to the young plant above certain concentrations, is rendered harmless by combination with aspartic acid, just as the ammonia of protein metabolism in the animal is rendered innocuous by conversion into urea. The analogy must not be pushed too far, however, as the asparagine must be considered as a storage material and not a waste product like urea.

Whatever may be the correct view of the exact course of these syntheses in the plant —and if it doubtful if any single explanation can be found to cover all of them—it may be unhesitatingly stated that the first substances that are formed and can be isolated as the result of the reactions between CO_2, water, and combined nitrogen are the sugars and the highly complex collodal bodies— the starches and proteins, whilst the vast majority of the other vital products such as fats, terpenes, alkaloids, colouring matters, to mention only a few, should be regarded as coming into existence at a later stage. Depending thus for the initial synthesis of complex molecules on the energy of the sun through the intervention of absorption screens and photocatalysts, our later experience of vital products obviously arises out of the chemical activity of the enzymes which cause the degeneration of the first-formed complexes—a process attended with the liberation of the absorhed energy.

It would perhaps be unprofitable at this stage of our knowledge to draw up a more detailed scheme of degradation of the complex photosynthesised products than that outlined above, but I would only make a passing reference to two of the most attractive explanations of phytochemical proceses that have been offered lately—the one proposed by Collie, in which the diverse products of plant metabolism like benzenes, pyrones, fats, terpenes, pyrrols, pyridines, anthocyanins and alkaloids, are all imagined to arise from a common origin, viz., chains of ketomethylene groups ($-CO-CH_2-$) produced either by the oxidation of carbohy-

drate chains or by the condensation of formaldehyde molecules to ketens followed by *polymerisation, and the other* developed by Robinson with reference to the synthesis of alkaloids based firstly, on his interesting and now familiar discovery that tropinone could be formed by the mere association of the di-aldehyde of succinic acid, methyl-amine, and a salt of acetone dicarboxylic acid in water without the assistance of a condensing agent or an increase of temperature, and secondly, on his investigations of the reactions between the higher amino-*acids and formaldehyde.*"

General Notes.

BOARD OF TRADE ANNOUNCEMENT.

DYESTUFFS (IMPORT REGULATION ACT, 1920.

APPLICATION FOR LICENCES IN OCTOBER, 1926.

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during October has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee.

The total number of applications received during the month was 753, of which 692 were from merchants or importers. To these should be added 8 cases outstanding on the 30th September, making a total for the month of 761.

CANADIAN MINING NOTES.

In no country in the world is there a better outlook in the mining industry than in Canada, and we may expect the industry to expand, and that rapidly." This was the statement, based on thirty years' experience, which Dr. Charles Camsell, Deputy Minister of Mines, made before a gathering of the business men of Winnipeg.

This statement, Dr. Camsell said, was based not only on the well-known and oft-declared fact that Canada possessed a vast territory, which was unprospected and undeveloped, but more on the almost un*believable increased demand in the world* to-day for new mineral resources.

OTTAWA ACCUMULATES GOLD.

The Natural Resources Intelligence Service at Ottawa reports that Canada is steadily accumulating gold at Ottawa due in part to the fact that Ontario mines are now shipping to the Dominion capital instead of to New York. Receipts of crude *gold bullion at the Royal Mint, Ottawa,* from Ontario mines for August totalled 125,726 crude ounces, containing 100,608 fine ounces of gold, and 17,127 of silver, with a total valuation of $2,090,363.

CANADA'S LEAD PRODUCTION.

FIRST HALF OF 1926.

Lead production from Canadian ores during the first six months of 1926 totalled 138,397,755 pounds which at the average Montreal price of 8.276 cents per pound, was valued at $11,453,798. This output marked an advance of nearly ten million pounds above the total reported for the first half of 1925. By far the greater part of Canada's output of lead was as usual, from the ores of the famous Sullivan mine in British Columbia.

FIRST HALF-YEAR'S NICKEL PRODUCTION.

Computed on the same basis as in previous semi-annual reports published by the Dominion Bureau of Statistics, nickel pro*duction in the first half of 1926 totalled* 39,418,707 pounds, valued at $14,190,734, as compared with 35,756,640 pounds, worth $11,442,125 during the first six months of 1925. A change in method was made in compiling the final figures for the year 1925. The foregoing figures represent the nickel content of matte made in the smelters of the Sudbury area, with small amounts of nickel credited to the smelters treating cobalt ores, the whole being valued at the average New York *price* of *virgin nickel.*

FELDSPAR.

Finally revised statistics just issued by the Mining, Metallurgical and Chemical Branch of the Dominion Bureau of Statistics at Ottawa show that the production of feldspar in Canada declined in 1925 to 28,631 tons valued at $235,789, a falling off of 16,123 tons, and $122,751 from the high level of 44,804 tons at $358,540 established in 1924.

THE FERTILISER INDUSTRY IN CANADA—1925.

Production from plants in Canada engaged primarily in the manufacture of complete fertilisers amounted in value to $1,437,787 in 1925. In addition, fertiliser materials such as calcium cyanamide, ammonium sulphate, animal tankage, ground bone and fish fertilisers, were made in factories classified under other industries; in 1925, the production value of these commodities amounted to $6,259,496.

Increases were noted in the output of acid phosphate, and in the production of complete fertilisers in the fertiliser industry proper, and greater tonnages were reported by the industries producing cyanamide, animal tankage, and ammonium sulphate. In addition to the manufactured fertilisers offered for sale there is also a large consumption for fertiliser purposes of imported nitrate of soda from Chile and muriate of sulphate of potash from Germany. These salts are often applied directly to the soil, without being mixed with other fertiliser ingredients. It must be noted, however, that only a part of the sodium nitrate imported is used for fertiliser purposes.

Importations of sodium nitrate amount toabout 22,000 tons annually but consumption in acid manufacture takes 13,500 tons, and a further 1,300 tons are used in the preparation of complete fertilisers, leaving approximately 7,200 tons, most of which is probably used directly on the soil.

Only 13 plants in Canada produced complete fertilisers as a major product; 6 were in Ontario, 3 in Nova Scotia, 2 in British Columbia, and 1 in each of Manitoba and New Brunswick. Capital employed in these plants amounted to $2,095,608 and the number of persons employed the year round was 201. Payments in salaries and wages totalled $205,173, and materials used in manufacture cost $1,045,294.

LONDON FIRE BRIGADE.

Yesterday and To-Day.

One of the most interesting and important features of the recent London Lord Mayor's Show was the engines, equipment and men representative of London fire brigades, past and present. As the powerful motor fire engines, replete with every appliance which science can suggest, and manned by highly trained crews, pass by in their splendour, it is perhaps difficult to help feeling amused at the primitive hand pumps, leather hose pipes and hooks which, in the hands of quaintly uniformed bands, protected our great city from "the mischiefs that happened by fire" in the days of our forbears. Still more surprising would it be to many to learn that the personnel and equipment which existed in those days were the direct outcome of private enterprise and effort.

It is actually only 60 years ago that the passing of the Metropolitan Fire Brigade Act proclaimed an open recognition of the fact that fire fightiug was rightfully the province of municipal authorities.

"In sixteen hundred and sixty-six, London burned like rotten sticks," runs the tag of our schooldays; and it was indeed the appalling catastrophe of that year which brought into prominence at once the inadequacy of our fire-fighting appliances, and the necessity for organised bodies of firemen. As the immediate result of the Great Fire, various laws were enacted making provision for "engines, firecocks and leather pipes," Such appliances, however, were under the supervision of the parish churchwardens.

Such was the condition of London's protection from fire when, towards the end of the 17th century, the fire insurance companies took steps to organise bodies of fire-fighting men, equipped in the best possible manner of the time. These men were recruited, appropriately enough, from the ranks of the Thames watermen. They donned uniforms, and by their distinctive colours and badges denoted the particular company employing them. They were well paid and were exempted by Queen Anne from the attentions of the "press-gangs." Under permanent foremen they were available at short notice, and although their services could be called upon in any case of fire, they existed mainly to quell outbreaks occurring in those buildings bearing the fire mark of their own companies. Such fire marks were in common use throughout the 18th and 19th centuries, and are still to be found, forming lasting emblems of the two hundred years during which the safety of the City in case of fire rested in the hands of the fire insurance companies.

Four of these institutions—incidentally the only four to have retained uninterrupted their individuality, took part in the recent Lord Mayor's Show—Sun (founded 1710), London Assurance (founded 1720), Royal Exchange (founded 1720), and Phœnix (founded 1782). Members of the present-day staff, wearing replicas of the uniforms

which distinguished their colleagues of old, with the identical engines employed from one to two hundred years ago, have been chosen to illustrate the fire brigades of 1710, 1750, 1791, and 1832. Whilst these period representations of the old fire fighters and their antiquated appliances may cause a smile, they will also compel the grateful remembrance that the insurance companies for a period of two hundred years have actually provided, at their own expense, the best possible service procurable at the time for preventing and extinguishing outbreaks of fire, efforts that ultimately culminated in giving to the Empire's Capital the world's most effective and most admired fire brigade as it exists to-day. The London Salvage Corps is solely maintained by the insurance companies, and the fire offices also contribute to the upkeep of the Fire Brigade.

GOVERNMENT TRANSPORT ORDERS.

We are officially informed by Messrs. Vickers Limited that they have received an order from Bibby Bros. & Co., to equip the motor vessels "Dorsetshire" and "Somersetshire," for service as Government transports.

PRINCIPAL FOREIGN CURRENCIES.

EXCHANGE PRICE ON OCTOBER 9, AND 30.

Place. Par.	9 Oct.	30 Oct.
New York—		
4.866 dollars = £1...	4.852	4.848
Paris—		
25.2215 francs = £1	169.531	156.417
Brussels—		
25.2215 francs = £1	176.458	*34.852
35 belga = £1		
Italy—		
25.2215 lire = £1 ...	125.813	114.208
Madrid—		
25.2215 pesetas = £1	32.354	32.052
Holland—		
12.1071 gul. = £1 ...	12.124	12.123
Berlin—		
20.43 reichsmarks = £1	20.374	20.385
Prague—		
24.02 koruna = £1...	163.709	163.615
Oslo (Christiana)—		
18.159 kroner = £1	22.153	19.428
Stockholm—		
18.159 kronor = £1	18.154	18.147
Copenhagen—		
18.159 kroner = £1	18.274	18.238
Switzerland—		
25.2215 francs = £1	25.115	25.137
Buenos Aires—		
47.58d. = 1 dollar ...	45.917	45.813

*Average closing rate for the "belga" for the five days October 26 to 30; the closing rate for the franc on 25 October was 174.188.

During October Belgium introduced a new coin, the "Belga," for all external transactions, but in Belgium itself the franc is to remain the legal currency. The Belga is fixed by law as worth 5 francs, so that the par value of 35.00 equals 175 francs.

It has a gold content of .209211 grain of fine gold.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

Thursday, November 11, 1926, at 4.30 p.m. (Joint meeting with the Royal Astronomical Society.)

1.—*Discussion of the Results Obtained at the Solar Eclipse of January 14, 1926.*

Speakers—Sir F. W. DYSON (chairman of the Joint Permanent Eclipse Committee); MR. C. R. DAVIDSON; MR. F. J. M. STRATTON; PROF. ORNSTEIN; DR. MINNAERT and others.

The eclipse was observed from Benkoelen, on the southern coast of Sumatra, under perfect observing conditions for the whole period of totality, 190 secs. Dr. F. W. Aston, with a 4-inch lens of 19 feet focal length, obtained four direct photographs of the corona of different exposures. The corona is of intermediate type, with many irregular streamers and with well-marked arches over one of the strongest prominences. At second and third contact a direct-vision prism was slid into position in front of the object-glass by Major Davies, and objective prism spectrograms were obtained of the flash for the range λ 3,900 to λ 5,000. These spectra show a wealth of detail, and in particular have been used in a study of the heights to which different elements, and differing atoms of the same element, rise. Col. Waley Cohen, working with a 4-inch lens of 38 feet focal length and a 6-inch objective prism, secured a large-scale spectrogram of the flash from Hβ to Hα. Two coronal rings are shown on this plate, and there is evidence of increased brightness of the corona at points associated with high prominence matter. Mr. Stratton, with the Grove-Hills slit spectroscope (two flint

prisms), endeavoured to secure certain lines of ionised calcium in the extreme infra-red. The dicyanin stain taken out proved to be of no use under the conditions of damp heat which prevailed. Prof. Curtis, with the Swarthmore expedition, stationed only a short distance away, kindly offered to stain some films, as he was getting better success with his stain, but the stain failed to bring up any lines beyond the oxygen triplet at 7772. The two coronal lines in the green and red were obtained with an iron-arc comparison spectrum, and the measured wave-lengths are found to be 5304.1, 6374.3 I.A.U., respectively. Mr. Davidson, with the Grove-Hills quartz spectroscope (four prisms), secured slit spectra of the flash and the corona in excellent focus from λ23066 to λ 4215.

The whole spectrum has been measured, comparison made with the results of previous investigations, and the lines grouped in series so far as the corresponding series have been established. In the coronal spcterum a high prominence fell upon the slit, so that an excellent scale for wave-lengths is provided for the coronal spectrum. The following are the wave-lengths determined: 3387.95, 3454.11, 3601.03, 3642.87, 3800.77, 3986.82, 4086.30 I.A.- the probable error of a wave-length should not be more than ± 0.05 A, including the uncertainty introduced by possible motion in the gases which give the lines in the spectrum of the prominence used as reference standards. Interesting variations in brightness of the different coronal lines from the values found in previous eclipses have been noted.

By permission of Prof. Ornstein, and with the help of Dr. Minnaert, the ultra-violet slit spectra have been analysed with the Moll recording spectra-micro-photometer at the Physical Laboratory at Utrecht. Amongst the results that this work has led to the following may be mentioned. The coronal lines have been divided into groups according to the distribution of the intensity along their lengths; differences of relative intensity of bright lines have been found in a comparison of the flash spectrum and of the high-level prominence spectrum on the coronal plate: these differences have been correlated with differences in the corresponding excitation potentials, lines of low excitation potential being relatively stronger in the higher level. The intensities of H and K have been examined up to a height of 100,000 km. Unfortunately the value of this and of a general comparison of intensity and height has been greatly lessened by the disturbing presence of strong prominences. Further, the relative intensities of the Balmer lines and the distribution of intensity in the continuous radiation which extends towards the ultra-violet from the head of the Balmer series have been studied. Attempts have been made to deduce the temperatures of different levels in the chromosphere, but the deduced temperatures have come out puzzingly low, with a tendency to fall for the lower layers, suggesting that the intensities are affected by some disturbing factors, such as light-scattering by atoms, or that the Sun's outer atmosphere is not in thermodynamic equilibrium. The intensity of the continuous spectrum found on the coronal plate, due apparently to the lower corona, does not appear to have the same distribution in wave-lengths as the solar spectrum.

2.—*The Solar Corona at the Eclipses from 1898 to 1919.* Communicated by the Astronomer Royal, President of the Joint Permanent Eclipse Committee.

Photographs of the Sun's corona have been obtained at numerous Eclipse Expeditions sent out by the Joint Permanent Eclipse Committee and by the Royal Observatory. Drawings from these are given in this paper, as it is very desirable that accurate representations of the form of the corona should be permanently recorded. A brief description is given with each plate, pointing out the most remarkable features upon it.

The association of prominences with disturbances, and particularly arches in the corona, is clearly indicated. The most striking fact brought out by these photographs is the change shown in 1901 of a prominence into coronal matter in less than two hours.

MINERALOGICAL SOCIETY.

The following papers were read at the meeting held on November 2. Professor W. W. Watts, President in the chair:—

Schultenite, a New Mineral from South-West Africa. By DR. L. J. SPENCER.

The colourless platy crystals from Tsumeb are monoclinic ($a : b : c = 0.8643 : 1 : 0.7181$, $\beta = 84° 36'$) and gave on analysis by E. D. Mountain the formula $PbHAsO_4$. They are identical with crystals prepared artificially by the late Baron A. de Schulten in 1904 (See *Nature*, Sept. 18, 1926, p. 411).

Aramayoite, a New Mineral from Bolivia. By Dr. L. J. Spencer.

This was found in 1925 in a silver-tin vein in the Animas mine at Chocaya. It shows a confused aggregate of cleavage plates with iron-black colour and brilliant metallic lustre. In addition to the perfect basal cleavage there are also good cleavages following a steep tetragonal pyramid. The mineral is pseudotetragonal. Analyses by T. B. McGhie and by E. D. Mountain give the formula $Ag(Sb,Bi)S_2$.

X-ray Examination of Aramayoite. By K. Yardley.

Some photographs taken with beam perpendicular to the perfect basal cleavage (001) show no symmetry; powder photographs also show that the tetragonal symmetry apparently indicated by the cleavages does not actually exist. Ionisation spectrometer data reveal the triclinic nature of the mineral and give a complete crystallographic description : a = 5.672 A.U. ; b = 5.688 ; c = 5.623 ; $\alpha = 86° 55'$; $\beta = 90° 53'$; $\gamma = 93° 18'$. The structure is pseudotetragonal with two molecules of $Ag(Sb, Bi)S_2$ in a minimum cell.

The Structure of Baddeleyite and of Prepared ZrO_2. By K. Yardley.

The natural form of ZrO_2 is monoclinic with four molecules in the unit cell. Ionisation spectrometer measurements on a single crystal and powder photographs both indicate a distorted CaF_2 arrangement of the ions. The structures of three specimens of the mineral from entirely different sources are practically identical, except for slight variations of spacing due to the presence of impurity. Powder photographs of prepared zirconia from two distinct sources are almost identical with those of baddeleyite and show that prepared zirconia is also monoclinic and not (as previously stated) tetragonal.

The Crystalline Structure of Zircon. By W. Binks.

X-ray examination of zircon shows the structure of zircon to correspond to the space group D_{4h}^{19}. The unit cell containing eight molecules $ZrSiO_4$ has dimensions a = 9.30, c = 5.93 A. The silicon and zirconium atoms form two interpenetrating face-centred lattices, and the oxygen atoms are arranged tetrahedrally around the silicon atoms. The structure has some resemblances to that of anhydrite ($CaSO_4$).

THE OPTICAL SOCIETY.

At a meeting of the Optical Society, held at the Imperial College of Science on Thursday, October 28, the folowing papers were read and discussed :—

The Analysis of an Interferogram. By R. Kingslake, A.R.C.S., M.C.

It has been frequently suggested that it should be possible to analyse mathematically the interferometer pattern produced by a lens, in order to obtain a measure of the aberrations from the coefficients of the terms in the various orders of x and y. x and y are here the co-ordinates of a point in the interferogram, whose optical path difference relative to the central ray of the lens is known at once by counting the fringes. This method has now been tried several times, using the utmost experimental precautions to secure accuracy, but the figures do not agree very closely with those obtained for the same lens under identical conditions by the oblique Hartmann test. Possible reasons for this disagreement are suggested.

The Stationary Value of Axially Symmetric Functions. Part II. By T. Smith, M.A., F.Inst.P.

Alternative methods to those described in Part I. of constructing a series representing the stationary value of a given function are developed and applied to evaluate all the terms not involving powers and products of the co-efficients of the function higher than the eleventh. The formula in its optical applications enables the first 451 monorythmic aberrations of a symmetrical optical instrument to be determined.

SOCIETY OF PUBLIC ANALYSTS.

An ordinary meeting of the Society was held at the Chemical Society's Rooms, Burlington House, on Wednesday, November 3, 1926, Mr. E. Richards Bolton, President, being in the chair.

A certificate was read for the first time in favour of Mr. Stanley Grove Burgess, B.Sc., A.I.C.

Certificates were read for the second time in favour of Miss Gertrude Garland Andrew, B.Sc; Messrs. Charles Edward Barrs, F.I.C.; Thomas Hedley Barry; Gordon Watson Douglas, B.Sc.; Clarence Victor Ferris, B.Sc., A.I.C.; and Reginald Charles Pakes, B.Sc.

Mr. Stafford Aston, F.I.C., was elected a Member of the Society.

NOTICES OF BOOKS.

Charles University of Prague: 1924 Calendar.

We have just received the 1924 Calendar of the Charles University of Prague. It conforms to the plan of English College calendars and contains much interesting information concerning the University. There is a list of Professors and Lecturers and this information is again duplicated in the description of the personnel of each Faculty and Institute.

The Calendar is prefaced by an Address from the retiring Rector, Prof. Cyril Horacek, who reviewed the progress made during his term of office, 1922-3. Obituary notices of professors deceased during this period are given, together with a review of their work. Prof. Horaček congratulated Prof. Leo Heyrovsky (sen.), Head of the Faculty of Law, on attaining his jubilee. He has, alas, since died.

The new Rector's address to the Fellows and students is also given.

The Calendar is illustrated with a number of photographs and contains much interesting statistical information. It is, however, entirely in Czech, and will, therefore, make little appeal to English readers.

J. G. F. D.

An Introduction to Physical Chemistry. By F. B. Minter, M.A., late scholar of Emmanuel College, Cambridge, Assistant Science Master, Clifton College. Pp. 16 + 274. Price 6s. London: Longmans Green & Co., 39, Paternoster Row, London, E.C.4.

This ought to prove a useful book for ambitious pupils who have passed the school certificate or London Matriculation Examination, inasmuch as it contains just the material to aid them in preparing for obtaining a higher certificate or University scholarship. There are given some four plates and numerous diagrams, while we also notice that the cross references are numerous (a decided advantage in any book of this kind. It will also be noticed that the price—6s.—is exceedingly moderate.

New Conceptions in Colloidal Chemistry. By Herbert Freundlich, Professor at the Kaiser William Institute for Physical Chemistry, Berlin. Pp. 148. London: Methuen & Co., Ltd., 36, Essex Street, W.C.2.

The book is largely made up of the subject matter of a series of lectures delivered in the U.S.A., during 1925, and written out in their present form by the author during a protracted visit to the University of Minnesota, U.S.A. It might be added that the author has been materially assisted in the preparation of the English text by Professor L. H. Regerson, while he also acknowledges assistance by Professor G. Barger, of Edinburgh.

Kelly's Directory of the Chemical Industries, 1926.

We have to acknowledge receipt of the 1926 edition of the above valuable reference book, which has just been pnblished. Pp. XXXII. + 974 + XX. Price 30s. London: Kelly's Directories, Limited. 186, Strand, W.C.

This Directory embraces England, Scotland, and Wales, and the principal places in Ireland, the Channel Islands, and the Isle of Man. It contains the names of those engaged in the many branches of the chemical industries, both the manufacturing and selling sides being adequately dealt with.

The following headings (selected from a total of some eight hundred) should give an indication of the wide scope of the information supplied:— Chemists and druggists and drug stores, 10,000 names; bottle manufacturers; chemical manufacturers, more than 90 separate headings; chemical merchants and exporters; chiropodists; dentists, essential oil merchants; homeopathic medicine vendors; patent medicine vendors; perfumers (both wholesale and retail); all branches of the photographic trades; mineral and soda water manufacturers.

The book comprises:—

1. A places section, giving the names for each county, arranged alphabetically under the towns and villages.
2. An alphabetical classification of trades for the London postal district, arranged with the names under each trade heading in alphabetical order.
3. A similar classification of trades, for the rest of England, Scotland and Wales.

There is also an alphabetical list of some 1,000 branded articles and specialities used in the chemical industries, together with the names and addresses of the manufacturers.

The Papermakers' Directory of all Nations, 1926. Pp. 984. Price 21s. net. London: Dean and Sons, Ltd., 29, King Street, Covent Garden.

This useful book for all directly and indirectly interested in the paper trade is well arranged, and up-to-date. It contains a large mass of special and general information.

FORTHCOMING EVENTS.

ROYAL INSTITUTION.

21, Albemarle Street, London, W.1.

Tuesdays, November 23, 30, December 7, 14, at 5.15 p.m.—Sir William Bragg, K.B.E., LL.D., F.R.S., M.R.I., Fullerian Professor of Chemistry: "The Imperfect Crystallisation of Common Things."

Saturdays, November 27 and December 4.—George C. Simpson, D.Sc., F.R.S., M.R.I. (Director, Meteorological Office): "Atmospheric Electricity."

THE INSTITUTION OF ELECTRICAL ENGINEERS.

South Midland Section.—Friday, November 26, at 7.p.m.—Annual Dinner at the Grand Hotel, Birmingham.

Mersey and N. Wales Section, at Laboratories of Applied Electricity, University, Liverpool, at 7 p.m.—J. R. Beard, M.A., and T. G. N. Haldane, B.A.: "The Design of City Distribution Systems."

North Eastern Centre. — Wednesday, November 24, at 7 p.m. Armstrong College, Newcastle-on-Tyne.—Prof. W. M. Thornton, O.B.E., D.Sc., Faraday Lecture on "What is Electricity?"

ROYAL SOCIETY OF ARTS.

Monday, November 22, at 8 p.m.—(Howard Lecture.) Professor Hugh L. Callendar, C.B.E., M.A., F.R.S.: "Recent Experiments on the Properties of Steam at High Pressure." (Lecture II.)

Wednesday, November 24.—Warre S. Bradley, Secretary, Messrs. Watney, Combe, Reid & Co., Ltd.: "Industrial Welfare in Practice." Sir Robert A. Hadfield, Bt., F.R.S., will preside.

CONFERENCE ON TAR.

A joint Conference on "Tar," under the auspices of The Coke Oven Managers' Association, The Institution of Gas Engineers, The Society of Chemical Industry (Fuel Section and Manchester Section), will take place on Friday, November 26, in the College of Technology, Sackville Street, Manchester.

There will be three Sessions of the Conference—Morning, Afternoon and Evening. The Rt. Hon. the Lord Mayor of Manchester—Ald. J. H. Swales—will open the proceedings at 10 a.m., by extending an official welcome, and will be supported by L. Guy Radcliffe, Esq., Chairman of the Manchester Section.

Professor Arthur Smithells, F.R.S., D.Sc., Chairman of the Fuel Section, will preside during the first Session.

Papers to be read:—

"A Study of Tars and Oils Obtained from Coal." By F. S. Sinnatt, Esq., and Dr. J. G. King.

"A Plea for Standardisation of Analytical Methods in Coal Tar Products Specifications." By W. Gordon Adam, Esq.

"The Viscosity of Tar." By H. M. Spiers, Esq.

The Consistency of Bitumen Mixtures." By H. M. Spiers, Esq.

"Notes on Vertical Retort Tar." By J. McLeod, Esq., in collaboration with C. Chapman and T. A. Wilson.

"The Production of Road Tar from Vertical Retorts." By Michael Barash, Esq.

"The Influence of Carbonising Conditions upon Free Carbon Content of Tar." By H. Hollings, Esq.

"Tar from Steamed Vertical Retorts." By Dr. Albert Parker.

"Tar from the Point of View of the Highway Authority." By W. Gordon Adam, Esq., in consultation with H. W. Robinson, Esq.

"Coal Tar Disinfectants." By A. C. Tait, Esq.

'The Evaluation of Pitch." By H. F. Taylor, Esq.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

26,645.—Agopian, L. A.—Production of concentrated preparations of vitamine-C. October 25th.

27,211.—Bates, C.—Elevating acids and C. October 30th.

27,015.—Goffrey, S. — Manufactnre of metal derivatives of B-diketones. October 28th.

26,625.—I. G. Farbenindustrie Akt.-Ges. —Vat dyestuffs. October 25th.

27,014.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of Alkaline. Oct. 28th.

Specifications Published.

237,291. Farbwerke Vorm. Meister, Lucius & Brunning.—Manufacture of vat dyestuffs.

260,047. Stutchbury, M. S. (Metallbank und Metallurgisch Ges. Akt.-Ges. Process for the production of sulphuric acid.

260,058. British Dyestuffs Corporation, Ltd., Saunders, K. H., and Mendoza, M.—Manufacture of new intermediates and dyestuffs.

260,159. Wolffenstein, Dr. R.—Nitrogenous derivatives of terpene-alcohols.

254,310. Bensa, F. Process for manufacturing nitriles of the perylene series.

Printed Copies of the full Published Specification may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

Abstract Published.

258,058. Antiseptics.—Crosnier, G. E. E., 137, Rue des Charrettes, Rouen, France.

An antiseptic and deodorant consists of a mixture of zinc sulphophenate, a second zinc salt such as the sulphate or chloride, and an alkaline or other soluble acetate not producing a precipitate with the zinc salts. The preparation may be made as a powder, as tablets, or as a solution. Inert substances such as borax, sea-salt, or other antiseptics may be added.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

NAPPABAG.

472,288.—Disinfectants. — Edwards and Critton, 36a, Plumstead High St., London, S.E.18. November 3rd.

AUREMETINE.

471,016.—Chemical substances prepared for use in medicine and pharmacy.—W. Martingdale, 10, New Cavendish Street, London, W.1. November 3rd.

CLARKE'S INDIAN LOTION.

471,534.—A medicated lotion for human use in the treatment of rheumatism.—Clarke's Indian Lotion, 2, Aston's Place, Dublin.

INTELLIGOL.

473,163.—Chemical substauces prepared for use in medicine and pharmacy.—August William Vesterling, 107, Castle Street, Battersea Park, London, S.W.11. November 3rd.

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SEARCH FOR THE ELEMENT OF ATOMIC NUMBER 61.—II.

By W. PRANDTL AND A. GRIMM*.

[EDITORIAL NOTE.—At the suggestion of F. H. Loring, Esq., we are publishing abstract translations of two recent papers in the *Zeitschr. f. angew. Chemie*, by Professor Prandtl (the second in collaboration with Dr. Grimm) on his experiments in search of the missing element of atomic number 61. It will be recalled that the papers by J. Allen Harris, B. Smith Hopkins and L. Yntema appeared in the *Journal of the American Chemical Society* (1926, XLVIII., 1585, 1594—June).

During the last sixty years the *Chemical News* has published so many important discoveries, including those connected with the discovery of new elements, that its readers will be particularly interested in these English renderings of Professor Prandtl's work.]

The intention of our first article (see *Chemical News*, this vol., p 323, Nov. 19), was to show that Harris, Yntema and Hopkins had, by their arc- and absorption-spectra, adduced no evidence for the existence of element 61, and their X-ray results were not complete enough.

Their later account (*J. Amer. Chem. Soc.*, 1926, XLVIII., 1585; June), which had the optimistic title " Element No. 61. Concentration and Isolation in Impure State," adds nothing to their earlier announcement.

Their X-ray spectrograph is of a type unknown to us, *viz.*, the Uhler type. It consists of a gas-filled tube with aluminium cathode and cooled copper anti-cathode. The spectrograph is not evacuated. They used a calcite crystal. The plate was at first 15.41 cm., from the crystal, but owing to air absorption this was later reduced to 8.81 cm. The dispersion at this distance is 0.03 mm. per Xunit. Their value of 0.5 mm. for the distance between the $L\alpha_1$ and $L\alpha_2$ lines of Sa only holds for their first arrangement of the plate. The current pressure was 30,000 volts and the density 8-10 milli-amps. Only the L spectrum was taken. The movement of the crystal was only through an angle of 30′, *i.e.*, it was worked as a fixed crystal. The spectral area thus covered only included the space

* Condensed translation from *Zeitschrift für angewandte Chemie*, 1926, XXXIX., 1333 (Nov. 4).

between the $L\alpha_1$ lines of the neighbouring elements 58 to 61, *i.e.*, at most 0.1 A or 100 X-units.

With regard to the strong absorption of the rays by air the exposure must therefore have been of long duration. The exposures lasted from $10\frac{1}{2}$ to $24\frac{1}{2}$ hours.

Under a long exposure the powdered rare earth oxides are blown off as dust from the anti-cathode, the specimens were therefore fused by an electric arc into deep ridges on the copper-plated anti-cathode. The lump of fused oxide so obtained was considered to be free from copper and was said to give no copper lines even after a long exposure. We have observed, on the other hand, that our spectrograms showed Pt lines if a platinum vessel was used in the preparation of the sample examined.

The Sa $L\alpha_1$ line served as reference line in the evaluation of the lines on the plate. Three different calcite crystals were used and six plates were taken, three with double Mg nitrate preparations and three with bromate preparations. Only one plate, from a bromate fracton, showed 61 $L\beta_1$ line. In all cases only weak lines were visible. The measurements gave an average value for the 61 $L\alpha_1$ 2278.1 X-units (calc 2277.7); lowest value 2273.0, highest 2280.3. The measurements of the 61 $L\beta_1$ was 2077.0 X-units (calc. 2073.0).

Harris, Yntema and Hopkins finally discussed the question of the possible presence of the lines Cr $K\alpha_3$ (2273), V $K\beta_1$ (2280), La $L\beta_7$ (2270) and β_{10} (2285) and Ce $L\beta_6$ (2277). They observed Ba $L\gamma_4$ (2072) close to the 61 $L\beta_1$, but thought its presence very unlikely owing to the slight solubility of its bromate. Overlapping of second and third order lines of Pt ($L\beta_1$ 1140), Ir ($L\beta_3$ 1138) etc., which would fall on the 61 $L\alpha_1$ and Br $K\alpha_1$ (1038) which would coincide with 61 $L\beta_1$ they also consider excluded.

Regarding the described procedure of Harris, Yntema and Hopkins, we wish to point out that an air-containing spectrograph for plates in the region of the rare earths, especially cerium earths, is not suitable as the rays in the region of wave lengths 2000 and more X-units would be strongly absorbed by air. Consequently a long exposure needed to give a strong spectrum interferes with the value of the ratio of the intensity of the lines and between the actual rays emitted and those as they appear on the plate. Second order L lines of higher atomic numbers or K lines of elements of lower At. No. are more strongly visible than the amounts of these elements express. The penetration power of a ray depends not only on its absolute wave length but also on its apparent wave length, which gives a higher order in the spectra. Through long exposure penetrating short-waved L rays of Pt or K rays of Br can become stronger than their amount justifies whilst small amounts of 61 would not be observed as they would be largely absorbed by air.

It is therefore not clearly established that the line said to be 61 $L\beta_1$ does not arise from the Br in the bromate. Also the so-called 61 $L\alpha_1$ may have resulted from traces of platinum derived from igniting the oxalates in platinum crucible.

The use of a vacuum spectrograph could remove these doubts. The shortening of the plate distance to overcome air absorption is done at the expense of the accuracy of measurement as it brings together overlapping lines.

Also the presence of Ba and Cr throughout is not so improbable as Harris, Yntema and Hopkins suppose. We have observed (*Zeitschr. anorg. Chem.*, 1924, CXXXIII., 369) in our fractionation of cerium earths with magnesium nitrate that the difficultly soluble barium nitrate occurs in al lfractions even when 50 are made.

The misplacement of Cr in the bromates is not quite excluded.

Possible contamination by other lines could have been convincingly excluded if Harris, Yntema and Hopkins had used a vacuum instrument, and by exposing the plates over a wider spectral area. It could then be seen which of the neighbouring elements were present in their preparations and to what impurities other lines were to be attributed. The intensities of the lines could also have been measured.

Plates over a wide spectral region would be important as allowing the 61 $L\alpha_1$ and $L\beta_1$ lines to appear on one plate, and their intensities could be compared. It is not satisfactory having two lines on different plates and from different materials attributed to the same element especially when the $L\beta_1$ appears stronger than the $L\alpha_1$.

It is also not clear why another plate was not taken with richer material to get the $L\alpha$ line together with the $L\beta$. Lack of material cannot be the reason. The breaking of the X-ray tube is also capable of repair, and could not be a satisfactory reason, unless the material was lost at the same time. But a fresh sample should have been made and re-examined.

Our judgment on the X-ray evidence which Harris, Yntema and Hopkins advance for the discovery of the element can be summarised :

The X-ray research of the rare earth mixtures was done with an apparatus not suited to the purpose. The presence of elements which give coinciding lines was not excluded. Afterwards in testing the same starting material with a vacuum spectrograph we have found no trace of 61. We therefore assume that the $L\alpha_1$ and $L\beta_1$ lines claimed by Harris, Yntema and Hopkins for 61 are due to contamination with small amounts of Br, Pt and Ba.

ON THE DETERGENT ACTION OF SOAPS.

By ROWLAND MARCUS WOODMAN.

(*School of Agriculture, University of Cambridge.*)

The work of Hillyer (*J. A. C. S.*, 1903, XXV., 511), and others, has shown that reduction in the surface tension between water and air, and, to a much greater extent, the interfacial tension between water and oil or grease, by the addition of soap, are important factors in determining the detergent action of soaps; grease and oil on the skin or fabrics are thereby emulsified with a consequent loosening of "dirt" particles.

Pickering later drew attention to the important fact that the actual solubility of oils in soaps and soap solutions probably determines the detergent action of soaps to a much greater extent than the lowering of interfacial tensions does, for actual solution of oils and grease is equally as efficient as emulsification for loosening "dirt" particles (*J. C. S.*, 1917, CXI., 86).

Typical results obtained by Pickering by shaking together a lighting oil and a potash soap—the excess of oil, of course, being emulsified—are given below for comparison with the author's :—

Lighting oil used (c.c.):	Oil dissolved (c.c.) by 100 gm. of anhydrous soap diluted with water: 100 c.c.	200 c.c.	300 c.c.	500 c.c.	900 c.c.	1900 c.c.
33	29.4	21.8	18.6	13.0	3.2	3.6
80	53.2	23.2	19.4	5.6	2.8	5.4

These results demonstrate as clearly as can be expected when analysis of mixtures of solutions and emulsions of hydrocarbons is in question, that two factors influence the amount of oil dissolved : (*a*) the greater the initial concentration of the soap solution, the greater the amount of oil dissolved, and, (*b*), the more oil initially present, the greater the solubility, per unit of soap.

During work on tree sprays necessitating determinations of solubilities of hydrocarbon oils in solutions containing soap, the writer's attention became directed to detergent action. It was found (*J. Pomology Hort. Sci.*, 1925, IV., 184; 1925 V., 43), that the presence of cresylic acid greatly increased the solvent action of fish-oil soft soap for paraffin (lighting) oil, the resulting solutions yielding in many cases with water clear solutions — unaffected by extreme dilution except sometimes for precipitation of acid soaps—containing 20 per cent. or less of oil; when the balance of cresols, soap, oil and water was not correct, mixtures of solutions and emulsions of the oil resulted. The soap used contained 50 per cent. of moisture, being, therefore, equivalent to the concentration for the two best results quoted above; 200gm. of this soap plus 100gm. of cresylic acid gave a solution miscible with 285c.c. of oil, the resulting solution dissolving on addition of more than a certain minimum of water to an aqueous *solution capable of extreme dilution.* Thus the addition of 100gm. of mixed cresols to 200gm. of soap "solution" containing 50 per cent. of water appears to increase the solvent action for lighting oil to over five times the best value quoted above; the importance of this increased solvent effect with regard to detergent action will be at once realised.

In the present experiments phenol itself and hydrogenated phenols, besides cresylic acid, have been used; solution of such substances as coal tar creosote, filtered anthracene oil ("green oil"), benzene and aniline has been attempted.

EXPERIMENTAL.

It was first necessary to ascertain the results of the addition of soap, or phenol,

or both, on the solubility of the substances under experiment in water. Because of the practical difficulties attending the analysis of solutions containing hydrocarbons, phenols and bases, and because of the large number of determinations made (many results will not be cited), a "synthetic" method of determining solubility at room temperature was used: the substance was titrated into a definite volume of the solvent (water, soap solution, or soap solution plus phenol), until turbidity persisted on continuous shaking, signifying that further additions of the substance were being emulsified and not dissolved.

Where soap solutions were the solvent, the soapy turbidity prevented the determination of solubilities of the hydrocarbon oils but, with the concentration of soap solutions used, and the small quantities of oil initially present by this titration method, the amounts of these oils completely soluble without any emulsification taking place are no doubt very small (Pickering, *loc. cit.*). In the cases of substances such as phenols, addition of small amounts cleared the soap solutions to bright sparkling liquids, subsequent clouding due to excess of solute being very sharp and definite. A few instances were noticed where turbidity persisted for a few minutes even with constant agitation before solution of the solute occurred, and, consequently, in order to arrive at the correct endpoint, the solute had to be added one drop at a time, with long shaking between each addition.

Table A indicates that the presence of soap in the solvent greatly increases the solubilities of phenol, cresylic acid, hexalin, methyl-hexalin and aniline. The more concentrated the soap solution, the greater the solubility of the phenols, hydrogenated phenols and aniline; in the case of the hydroxyl compounds, doubling the concentration of the soap solutions means that more than twice as much solute liquid is dissolved by a given volume of solvent.

TABLE A.

100 c.c. OF SOLVENT IN ALL CASES.

Solvent liquid:	Solute liquid:	c.c. of solute disolved before turbidity[1]:	Solvent liquid:	Solute liquid:	c.c. of solute disolved before turbidity[1]:
Water[2]	phenol	8.18	soap solution[3] (5 per cent.)	methyl-hexalin	9.75
,,	cresylic acid	1.50	,, ,,	aniline	6.80
,,	hexalin	0.50	soap solution[3] (10 per cent.)	phenol	>100
,,	methyl-hexalin	0.15	,, ,,	cresylic acid	21[4]
,,	aniline	3.00	,, ,,	hexalin	36.50
Soap solution[3] (5 per cent.)	phenol	57.00	,, ,,	methyl-hexalin	30.60
,, ,,	cresylic acid	9.55	,, ,,	aniline	10.50
,, ,,	hexalin	14.25			

[1] This column represents the maximum amount of solute completely soluble (without any emulsification; it is possible, in view of Pickering's work, that this amount is not the maximum amount of solute soluble under any conditions, e.g., when emulsification of solute is simultaneously possible, and the initial amount of solute is varied.

[2] Distilled water in all cases, to avoid precipitation of acid soaps.

[3] The concentrations refer to anhydrous pot. oleate in Tables A and B. It has been noticed in experimenting with different soaps that the capacity of aiding solution of oils depends on the type or composition of the soap; for this reason a stock quantity of comparatively pure pot. oleate was made for use in these experiments.

[4] Approximate value; difficult to judge owing to formation of jellies and "mucilages." (Woodman, *loc. cit.*)

Table B contains the solubilities of the substances in mixtures of soap solutions and phenols or hydrogenated phenols; a definite volume (in excess of that required to clear the soapy turbidity) of the hydroxyl compound was added to a definite volume of soap solution and the solute titrated in until turbidity persisted on continuous shaking; more of the hydroxyl compound was now added, and a new solubility determined for this extra amount by continuing the titration. The process was repeated until further addition of hydroxyl compound failed to clear the turbidity (usually intensifying it), and thus one titration was made to yield a few solubilities.

TABLE B.

Solvent :					Solute :[1]	c.c. Solute Soluble before Turbidity :			
100 c.c. 5% soap solution + phenol (c.c.) : ...	10	18	28	—	paraffin oil[2]	2.10	4.36	t.	—
" "	28	—	—	—	paraffin oil	2.90	—	—	—
" "	10	18	28	—	benzene[3]	4.26	5.06	t.	—
" "	10	18	28	—	coal tar cresote[4]	0.70	2.54	t.	—
" "	10	18	28	40	anthracene oil[4] ...	0.64	2.14	2.84	t.
" "	10	18	—	—	aniline	1.88	t.	—	—
100 c.c. 5% soap solution + cresylic acid (c.c.) :	8	—	—	—	paraffin oil	0.50	—	—	—
" "	8	—	—	—	benzene	0.24	—	—	—
" "	8	—	—	—	coal tar creosote...	t.	—	—	—
" "	8	—	—	—	anthracene oil ...	t.	—	—	—
" "	8	—	—	—	aniline	0.68	—	—	—
100 c.c. 5% soap solntion + hexalin (c.c.) : ...	8	10	—	—	paraffin oil	2.82	4.68	—	—
" "	8	10	—	—	benzene	4.02	4.74	—	—
" "	8	—	—	—	coal tar creosote	1.20	—	—	—
" "	8	—	—	—	anthracene oil ...	1.30	—	—	—
" "	8	—	—	—	aniline	5.12	—	—	—
100 c.c. 5% soap solution + methyl-hexalin (c.c.) :	8	—	—	—	paraffin oil	0.20	—	—	—
" "	8	—	—	—	benzene	2.20	—	—	—
" "	8	—	—	—	coal tar creosote...	t.	—	—	—
" "	8	—	—	—	anthracene oil	t.	—	—	—
" "	8	—	—	—	aniline	2.00	—	—	—

t. = turbid.

[1] Linseed oil, olive oil and oleic acid were found insoluble in any of these circumstances.

[2] The paraffin oil was a "best" oil bought at a local pharmacy. It was purified by shaking repeatedly with fresh lots of concentrated sulphuric acid until finally the acid assumed a straw-coloured tint only. The oil was then washed with dilute sodium hydroxide solution, then with distilled water, dried over anhydrous pot. carbonate and fractionally distilled. The oil was thus of known fractional composition; for the purposes of these experiments the fractions were mixed, giving an oil of B.P. = 145—300° C., and of $D^{20°}_{4°} = 0.7884$.

[3] Purified in usual manner, B.P. = 80.35—80.50° C.

[4] B.D.H. pure samples; anthracene oil, $D^{20°}_{4°} = 1.100$; coal tar cresote, $D^{20°}_{4°} = 1.005$.

(To be Concluded Next Week.)

THE REVERSAL OF CHEMICAL REACTIONS BY ELECTROLYSIS.

By ROBERT SAXON, B.Sc., F.C.S.

In all these experiments heavy voltage is used, that of the ordinary lighting current through four lamps as resistance.

It is sought to reverse such reactions as the following:

$$Ca : Cl_2 / Na_2 : SO_4 \quad CaSO_4 / 2(Na : Cl)$$

where ionised or dissolved calcium chloride and sodium sulphate give a precipitate (unionised) of calcium sulphate and sodium chloride solute. The object therefore is to take a precipitate and dissolve it by decomposing it and reversing what chemistry is wont to do.

Carbon electrodes are used and ammonium chloride instead of sodium chloride, as it is possible to get rid of excess afterwards by heating. A porous pot is cleaned by running the current through it in an electrolyte of ammonium chloride, afterwards of caustic soda, washing and soaking in clean water several times. The products of electrolysis are so often colloidal hydroxides that this is necessary.

Calcium Fluoride and ammonium chloride are placed in the porous pot as anode chamber, and the whole of the twenty grams taken changes from *amorphous* to *crystalline fluoride* after three hours' running, with rise of temperature from 15 to 83 degrees cent. The crystals examined under the microscope show phosphorescent glow in the dark, which dies away in four hours, and the crystals are remarkably like snow crystals. This crystallisation points to solution and deposition. The ammonium chloride regained is 9.4 per cent. less than the original weight. Solution does certainly precede crystallisation and probably results from interaction between calcium chloride formed during the reaction and hydrochloric acid or ammonium flouride, for 0.62 grams of calcium chloride are recovered, and the fluoride taken shows no trace of it.

Gypsum powdered is next taken along with the ammonium chloride, which is used in every experiment. Twenty grams yield 0.761 grams of calcium chloride. The impurity consists of iron and manganese.

Dolomite yields calcium and magnesium chlorides and magnesium oxide.

Clear *Iceland Spar* yields 23 per cent. of its calcium as chloride.

Strontium Sulphate gives but 4 per cent. of its base as chloride.

Calamine gives a ready and abundant delivery of zinc chloride, behaving like calcium carbonate, turning out 21 per cent. of its zinc in that form, and 7 per cent. as hydroxide in beautifully transparent colloid form.

Zinc Blende is much more tenacious, yielding only 8 per cent. as chloride and a trace of the hydroxide. In both cases the hydroxide increases in amount as the reaction is allowed to go on.

Iron Pyrites give very little iron as chloride. Further experiments are in progress.

Undoubtedly the electric current does reverse chemical reaction. It must be remembered that the interacting substances are lying side by side trying to upset the work of the current whenever it has brought about mutual displacement. If the soluble chloride could be removed as fast as it is formed the yield would probably be greater. Nascent chlorine will not do what the current does, and it might be that the current tends to lower acidity to one common level aiding the chlorine unattached to replace other radicles.

POSITIVE DRIVE INFINITELY VARIABLE GEAR.

A NOTABLE ACHIEVEMENT OF GREAT INTEREST TO CHEMICAL ENGINEERING.

By A WELL-KNOWN ENGINEER.

There has now been solved one of the oldest problems in the mechanical transmission of power in the shape of the "P.I.V." (Positive Infinitely Variable) gear whereby, there is given, smoothly and noiselessly, an infinite number of speed variations within the range of the gear supplied, between a driving and a driven shaft, with true positive (non-slipping) transmission. This constitutes a remarkable advance on short centre complicated gears, such as used in a motor car, which only allows of a very few speed changes, and on non-positive devices of the nature of a belt with cone pulleys, and enables accurate speed control in machinery to be obtained in a manner hitherto regarded as impossible.

The subject is of particular interest for example to the chemical and allied industries, to chemical engineering generally, and also in connection with many scientific instruments, such as large astronomical telescopes for example.

The invention is a production of Messrs. The P.I.V., Gear Syndicate, Ltd, 7, Princes Street, Westminster, S.W.1., being British throughout and the standard design consists essentially of a pair of expanding pulleys of the conical disc type, at any centre down to a few inches, one set on each shaft, between which runs a chain of entirely new design, engaging positively with the pulleys at the edges as it runs between the "V" of the pulleys. The inner sloping surfaces of the latter have alternate ribs and grooves so that the chain rises or sinks in the latter according to the movement of the pulleys along the shafts, giving a different effective driving diameter and allowing therefore of infinite variation in speed ratio. Also the drive is truly positive the engagement being obtained by each link having thin steel plates or slats which are free to move transversely and are gripped by the ribs which play the part of teeth, while the whole arrangement when at short centres can be totally enclosed in a small compact gear box, forming also an oil bath, with complete protection against coal dust, gas, fumes, steam, and other deleterious influences.

Included in the many applications it must be mentioned that with the "P.I.V." gear it is now possible with an open chain shaft drive at any centre to use a constant speed A/C motor and at the same time have an infinity of speed variation in the driven shaft as adjusted merely by a single handle or wheel control. That is to say the A/C motor is now available for direct variable speed work, and it is no longer necessary to use D/C motors and transformers, a great advance in the general principle of electrical driving of chemical works and other industrial establishments. Further it is possible by means of a "P.I.V." gear box to have the speed of a driven shaft varied constantly and automatically within any pre-determined range, while one of the next developments is an infinitely variable speed gear for motor cycles.

General Notes.

ASBESTOS IN CANADA.

Shipments of asbestos from Canadian mines during the first half of 1926 were considerably higher than those reported for the corresponding period of the preceding year. The total mill output during the period amounted to 153,499 tons while the quantity shipped totalled 132,644 tons, valued at $4,512,219. In the first six months of 1925, shipments amounted to 120,800 tons of asbestos, worth $,962,304. The average selling price obtained by the operator was $34.02 per ton as compared with $30.80 in the first half of 1925.

Asbestos rock mined totalled 2,212,678 tons, while in the corresponding period of 1925, the quantity of crude material mined was 1,786,812 tons.

Exports of asbestos reached a total of 131,648 tons, consisting of 68,541 tons crude, worth $4,111,124, and 63,107 tons of sand and waste, valued at $879,202.

GYPSUM IN CANADA.

Gypsum is second only to coal as the most important mineral produced in the Provinces of Nova Scotia and New Brunswick, where it has been mined for more than a century.

The six months ended June 30 marked a considerable advance in the production of gypsum in Canada. Shipments totalled 250,369 tons valued at $964,638 as compared with 254,706 tons, worth $906,052, shipped in the same period of 1925. The production by provinces was as follows: Nova Scotia, 167,562 tons; New Brunswick, 19,504 tons; Ontario, 37,754 tons; Manitoba, 18,439 tons; and British Columbia, 7,110 tons. Average values per ton received by operators, follow: lump, $1.48; crushed, $1.84; fine ground $5.96; and calcined, $9.46. The total quantity of gypsum mined in Canada during the period was 277,541 tons, of which 75,886 tons, or 27.3 per cent. was calcined.

Imports of gypsum were recorded at 545 tons, worth $19,841, and exports of Canadian gypsum amounted to 152,585 tons made up of 145,650 tons crude and 6,935 tons ground, with a total value of $323,274.

IPECACUANHA IN BRITISH MALAYA.

Some interesting particulars upon a product little considered hitherto, contained in a recent minute upon Ipecacuanha written by the Agriculturist, Straits Settlements and Federated Malay States Department of Agriculture, have been received by the Malay States Information Agency. After mentioning that the present experimental scale of the crop precludes as yet the furnishing of any figures as to cost of production, the Agriculturist writes as follows:

"As regards yield, our records show that the average yield of dried roots for mature plant (say 2½ years old), is 23 grammes, or about 6/7 ozs. A shaded nursery bed 66ft. long and 5ft. wide holds about 240 plants, and should yield about 10lbs. of dried root. Thus, allowing 88 beds per acre, the calculated yield is about 880 lbs. of marketable roots per acre. Until we have records of yields of plants grown on a bigger scale, I consider that it would be safer to adopt the more conservative estimate of 600lbs. per acre as stated in *Malayan Agriculture*, 1924, p. 211. The present price of Ipecac roots (14s. per lb.), should make it a very profitable crop to grow, but any very large increase in production would probably soon bring the price down considerably."

ADOPTION OF THE METRIC SYSTEM OF WEIGHTS AND MEASURES IN MEXICO.

The British Commercial Secretary at Mexico City reports that for some time past the Mexican Government has endeavoured to enforce the provisions of the Law of 1905 whereby the use of the metric system became compulsory. The phatciee of expressing weights and measures in the old Spanish units is, however, deeply rooted in Mexico, and the Weights and Measures Department of the Secretariat of Industry, Commerce and Labour realise that a considerable period may elapse before the legal system is generally adopted in the country.

(*From the "Journal of the Society of Chemical Industry," Japan.*)

STUDIES ON INFLAMMABILITY OF HYDROGEN. I. — INFUENCES OF ETHYL BROMIDE ON THE LIMITS OF INFLAMMABILITY OF HYDROGEN-AIR MIXTURES.

By Yoshio Tanaka and Yuzaburo Nagai.

The present authors investigated the influence of ethyl bromide vapour on the limits of inflammability of hydrogen-air mixtures. All limits were determined in a glass tube of 5 cm. in diameter and 65 cm. long, in which hydrogen-air mixture was ignited from the top by electric spark, both ends of the tube being opened before the ignition.

The results are shown in the following table :—

Mol. per cent. of ethyl bromide in limit mixtures.	Mol. per cent. of hydrogen in limit mixtures. Lower limit.	Upper limit.
0	8.89	71.2
0.25	—	62
0.50	—	56
1.00	—	49
1.50	7.2	—
2.00	—	41
2.70	6.2	—
3.00	—	34
3.75	5.3	—
3.90	—	.27
4.50	4.7	—
5.00	—	21
6.00	3.5	12
6.6	Flame could not propagate in mixtures containing 4.5, 5.5 and 6.1 per cent. of hydrogen.	

The theoretical flame propagation temperature of hydrogen calculated from its upper limit (71.2 per cent.) is 875° C., but on calculating the theoretical flame temperature of the mixture (56.0 per cent. of hydrogen) the authors obtained 1550° C., which must be the theoretical flame propagation temperature necessary to activate ethyl bromide molecules in the flame of hydrogen, and is higher than that necessary to activate hydrogen molecules.

As above described, the theoretical flame propagation temperature of hydrogen, which is the measure of its effective ignition temperature, is exceedingly lower than that of ethyl bromide, the latter being about 1550° C. in flame of hydrogen according to the present authors. Therefore, in the flame propagating in the hydrogen-air mixtures containing a small amount of ethyl bromides, the molecules of the latter become of higher quantum states, which differ from its active state, in expense of energy of the activated molecules present in flame, and the activation of hydrogen is thus prevented and consequently when the more ethyl bromide is added the higher temperature is necessary to activate hydrogen, resulting thus the lowering of upper limit of inflammability of the mixture, until finally the flame temperature of 1550° C. is reached, at which ethyl bromide is also activated to burn and its action to prevent the activation of hydrogen decreases markedly. Thus in the upper limit mixtures containing more than about 0.7 per cent. of ethyl bromide, hydrogen behaves

as if it had the theoretical flame progagation temperature of 1550° C., and consequently Le Chatelier's rule is closely followed by these mixtures.

DENATURANTS OF FUEL ALCOHOL.

By Yoshio Tanaka, Tsutomu Kuwata and Isamu Arakawa.

The well-known denaturants used generally in these days, such as pyridine, wood spirit, acetone oil, ether, benzene and others, were tested as to their denaturing effects by distillation, dilution and some other physical and chemical methods which were thought to enable the economical recovery of pure alcohol from the denatured alcohol in commercial scale.

For distillation test, an experimental distillation apparatus having Lessing's still head was devised. It has an equal efficiency as Igles or Guillaum still.

Pyridine was easily removed from alcohol by the simple distillation, it mainly remaining in the residue, and nearly pure alcohol was obtainedi n yield of 90 per cent., but very minute quantity of pyridine as 0.0001 per cent. was always distilled all over the fractions. This quantity of pyridine can not be detected by its odour but was sufficient to detect by the colour reaction of aniline. Wood spirit, acetone oil and ether, were also remoevd by the careful distillation, pure alcohol being recovered in yield of 90 per cent. Benzene and gasoline could not be removed by the simple distillation owing to the formation of azeotropic mixtures with alcohol, but by the previous dilution of the denatured alcohol with water, 70-80 per cent. of these hydrocarbons were separated and pure alcohol was recovered from alcohol solution, from which a bulk of hydrocarbons was removed with the yield of 80-90 per cent.

The new denaturants recommended by the authors to be more efficient than those stated above, were some organic sulphur compounds like mercaptol (acetone-diethylmercaptol) or an oil obtained by cracking culcanised fatty oils, treated with acetone oil. Crude mercaptols and the like have very offensive odours and the addition of these compounds as denaturants in only 0.01-0.05 per cent. made the alcohol unfit to drink. They have no harmful effects on engine parts in such a minute amount and, *moreover, they are negative to Doctor test.*

To make difficult the separation of benzene and gasoline from alcohol on dilution with water, 0.1 per cent. of turkey-red oil was added as emulsifier.

Two examples of the denaturing formulas are as follows :—

Example I.

Crude mercaptol	0.1%
Gasoline	5.0
Pyridine	0.1
Turkey red oil	0.1
Ammonia water	0.5

Cracked oil of vulcanised fatty

Example II.

oil	0.5%
Gasoline	5.0
Acetone oil	3.0
Turkey red oil	0.1
Ammonia Water	0.4

These substances were mixed to alcohol by volume percentage. The denatured alcohol became stable milky state when diluted with water and by the repeated distillations, the peculiar odour of the sulphur compounds were never removed from the alcohol.

After the troublesome treatments with 20-30 per cent. of activated charcoal (Norit) before or after distillation, the maximum recovery of alcohol amounted to only 70 per cent. of the original quantity of alcohol. Commercial animal charcoal had no effect of adsorbing these peculiar sulphur compounds.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE ROYAL SOCIETY.

Paper read on Thursday, November 18.

The Chemical Nature of Hæmochromogen and its Carbon Monoxide Compound. By R. Hill. Communicated by Sir Frederick Hopkins, F.R.S.

1. The hæmochromogen type of spectrum shown by compounds of hæmatoporphyrin with metals other than iron is not due to the presence of nitrogen compounds. It is suggested that the property of forming hæmochromogens is limited to the iron-porphyrin compounds.

2. Two molecules of pyridine are necessary to convert reduced hæmatin into corresponding hæmochromogen.

3. Carbon-monoxide hæmochromogen has one molecule of pyridine in combination when produced in the presence of the latter.

4. The carbon-monoxide compounds of reduced hæmatin and pyridin hæmochromo-

gen both contain one molecule of carbon monoxide.

5. *On the basis of the experiments* with pyridine, and by the parallel changes in spectra produced by other nitrogen compounds, general formulæ for hæmochromogen and its carbon monoxide compound are proposed.

THE CHEMICAL SOCIETY.

Papers read on Thursday, November 18.

The Unsaturation of Heterocyclic Ring Systems. Part I. The Benzthiazole and 1 : 2-dihydrobenzthiazole Sytsem. By R. F. Hunter.

The unsaturation of a considerable number of benzthiazoles has been studied.

The Unsaturation of Heterocyclic Ring Systems. Part II. The 2-amino-4-keto-tetrahydrothiazole System. By R. F. Hunter and H. Morland.

According to the conditions of substitution, the tetrahydrothiazole system gives rise to dibromides, tetrabromides, hexabromides, or octabromides $Br(Br_3)N <> SBr(Br_3)$. On degradation, the octa- and hexa-derivatives yield tetrabromides, and the tetrabromides yield dibromides. Certain dibromides on prolonged exposure to moist air yield hydrobromides.

The Chemistry of the Three-Carbon System. Part X. The Mobility of some Cyclic Ketones. By G. A. R. Kon and J. H. Nutland.

The following compounds have now been investigated from the point of view of three-carbon tautomerism : Δ^1-*cyclo*hexenyl*cyclo*hexanone, *cyclo*pentylidene*cyclo*pentanone, *iso*propylidene*cyclo*pentanone, camphorphorone, pulegone and *iso*pulegone; in all these compounds the keto-group is included in a five- or six-membered ring. The behaviour of these compounds is similar to that of *cyclo*hexenylacetone in that they all show the characteristic additive reactions of $\alpha\beta$-unsaturated ketones, but they form sodio-derivatives and alkyl derivatives which have necessarily a $\beta\gamma$-unsaturated structure. The relationship between pulegone and *iso*pulegone is similar to that existing between the ketones $CEt_2 : CH.COMe$ and $CHMe : CEt : CH_2 COMe$, because although they are distinct they give the same condensation product with ethyl cyanoacetate and the same methyl*iso*pulegone on methylation; the latter is evidently derived from a common sodio-derivative.

The Parachor and Chemical Constitution. Part IV. Three-membered and Four-membered Rings. By S. Sugden and H. Wilkins.

From measurements of the surface tension and density of a number of compounds containing three- and four-membered rings the effect of these structures on the parachor is found to be given by the constants 16.7 and 11.6 respectively. Amongst the substances measured are the normal and labile esters of 3-methyl*cyclo*propen-1 : 2-dicarboxylic acid; both forms give constants which indicate that they contain a three-membered ring and a nonpolar double linking. It is further shown that the structural parachors for double and triple linkings and for ring systems are proportional to the degree of unsaturation of the structure concerned.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

At the proceedings on November 3, a sum of £2,000 per year was allocated to the Research Committee.

Mr. Luddington, chairman, reported that the list of analyses made for members by the Consulting Chemist during the months of August, September and October had been submitted to the Committee.

Dr. Voelcker had reported on the present position with regard to the Fertilisers and Feeding Stuffs Bill.

The following report had also been presented by Dr. Voelcker on matters arising out of his correspondence :—

1. "*Grass Nuts*" not of composition stated.

A member sent me a sample of grass stated to be made up of decorticated cotton seed meal, locust bean meal, oats, barley and wheat. On examination I found it to be composed principally of wheat offals and oats, the analysis being very similar to that of "Middlings." There was no barley present, and there were only small quantities of cotton seed and locust bean. On the other hand, rice and maize were alike comprised.

2. *Oatmeal*—really Oat Refuse.

A purchase of four tons of meal for pig-feeding and sold under the name of "Oatmeal" at £7 10s. per ton proved to be nothing more than oat refuse from some manufacturing process. The analysis was :

Moisture	7.11
Oil	2.76
Albuminoids	6.69
Carbohydrates, etc.	54.85
Woody fibre	23.41
*Mineral matter	5.18
	100.00
Nitrogen	1.07
*Including sand and silica	3.98

This material, it will be seen, contained no less than 23.4 per cent. of woody fibre, with 4 per cent. of siliceous matter, and was a very undesirable one to give to pigs. It was practically nothing more than ground oat husks.

3. *Empire Stock Conditioner.*—A Novel Form of Insurance.

A member sent me a material sold under the above name, the price of which was £1 per ½ cwt. (£40 a ton), the purchase and use of which, for a period of six months' continuous feeding, according to directions given, constituting, in effect, a guarantee against the death of animals to which it was given during the period.

On making an analysis of the material I found it to be nothing but finely ground carbonate of lime, the value of which would be 30s. per ton.

4. *Coke*—contents of Arsenic.

In consequence of the difficulty in obtaining anthracite, coke has been in many cases employed in hop-kilns, etc., and the question of the extent to which arsenic may be present comes to be of importance.

In a sample of coke sent me by a member the amount found was 6 parts per million (one twenty-third grain per lb.) only, which is by no means high. By a special mode of treatment (heating with lime) it is possible to fix the arsenic contained in the coke, so that this is not volatilised.

5. Crops Destroyed by Sewage containing Galvanising Waste.

A member sent me a sample of soil on which, when in grass, sewage, which included refuse from galvanising works, had been run at intervals since 1922. On ploughing up the grass and putting in mangels and sugar beet, the crops failed almost entirely, leaving large bare patches.

The soil was accordingly sent to me, and, on analysing it, I found it to contain zinc to the extent of 0.77 per cent. It so happened that, at the Woburn Pot-culture Station, I had experimented in the years 1909, 1910, and 1913 (see *Journal*, R.A.S.E., 1910, p. 345; 1912, pp. 321-325; 1913, pp. 411-414) on the influence of different compound sof zinc on the wheat crop, and I found that the presence in a soil of anything over .02 per cent. of zinc from any of its salts, would prove toxic to the plant. I had little doubt, therefore, that the sterility of the soil was due to the presence of metallic salts from the galvanising waste sent down with the sewage, and that this had accumulated in the land, causing it to be harmful to the germination of the root crop.

Mr. Luddington, in moving the adoption of the report, wished to allude to one matter in Dr. Voelcker's report. A member of the Society was offered some condition powder at the rate of £40 a ton, and there was a guarantee given to him that if he used it for six months the vendors would be responsible for any loss of stock during that period. He sent the powder to Dr. Voelcker to be analysed, and Dr. Voelcker found that it was only carbonate of lime, which was worth about 30s. a ton. He also found that if the member followed the directions given by the vendors and gave the powder to his stock for six months it would cost him £300. It seemed to the Committee that that altogether novel form of advertising ought to be widely known by the members of the Society and the agricultural world in general. Dr. Voelcker had sent particulars to the Ministry of Agriculture, and the Committee thought he had acted wisely in so doing. It seemed to him (Mr. Luddington) that the matter was one that ought to be very widely known and that members ought to be warned about it.

GEOLOGICAL SOCIETY OF LONDON.

The following paper was read at the meeting held on November 3, 1926, Dr. F. A. Bather, M.A., F.R.S., President, in the chair:—

Jurassic Chronology: III. Some Faunal Horizons in Cornbrash. By SYDNEY S. BUCKMAN, F.G.S.

A few words of introduction show that the phenomenon of faunal dissimilarity within strata of a supposedly synchronous time-unit, the Cornbrash, had been observed about 70 years ago, but had not been understood. These remarks are followed by a short historical summary as to what had been done in the dating of the British Cornbrash, continued by proposals for a series of stratigraphical terms.

A fuller chronology of the Cornbrash is attempted, based on a series of faunal analyses of the Brachiopod species south of the Humber. Such analyses, placed diagrammatically in relation to an over-riding stratum of Oxfordian date, disclose a series of synclines, anticlines, and various non-sequences in the strata of the South Humbrian Cornbrash.

The Ammonoid horizons of the Cornbrash are then considered, and the divisions of Cornbrash time on the basis of Brachiopods and of Ammonoids are compared. Further, the Cornbrash and the Inferior Oolite are compared on these bases, and the conclusion is reached that, either the Cornbrash Brachiopod species be the same in the Cornbrash as in the Inferior Oolite—and there is every reason that it should be—then the Cornbrash must have taken in deposition a time far in excess of that of the Middle and Upper Inferior Oolite, with all its numerous Ammonoid hemeræ.

The persistence of the Cornbrash and its relation to questions of palæogeographical cartography are then considered, followed by remarks on straddle- or bridge-formations—deposits of similar character running on to connect two eriods or two Ages without any appreciable break.

In interesting discussion followed.

NOTICES OF BOOKS.

Chemistry of the Oil Industries. By J. E. Southcombe, M.Sc., Chief Chemist of the Henry Wells Oil Co., Salford; Lecturer on Oils and Fats, Royal Salford Technical Institute, etc. Pp. 224. Price 12s. 6d. net. London: Constable and Co., 10-12, Orange Street, Leicester Square, W.C.2.

Oils and fats fill such an important place in the industries of the country that a work of this kind by an accomplished author, and a specialist in the subjects with which he deals, is very welcome. The present is a second edition, the work having been enlarged and revised. The author refers to oil in the earliest times and the crude methods employed in its extraction, and then deals with the modern methods, beginning with the 18th century, but, of course, being steadily improved up to the present day. He pays a tribute to Eugène Chevreul, the French chemist, who in 1813, discovered the true composition of fatty matter, being able thereby to place the component parts of it in a definite class of chemical. He points out how imperfectly understood, even at the present day, are many of the chemical and physcial forces connected especially with soap works, so that there is still plenty of scope for research and experiment. The author throws additional light on many phases of his subject, utilising for his purpose, many home and foreign authors' publications.

A Text Book of Rand Metallurgical Practice. Designed as a "working tool" and practical guide for metallurgists on the Witwatersrand and other similar fields. By the following Authors: Ralph Stokes, Jas. E. Thomas, G. O. Smart, W. R. Dowling, H. A. White, E. H. Johnson, W. A. Caldecott, A. McA. Johnston. In two Volumes (each volume complete in itself). Vol 1., third and revised edition. Pp. XXII. + 564, with 128 illustrations. Price 30s. net. London: Charles Griffin & Company, Ltd., 42, Drury Lane, W.C.2.

This can be set down as an authoritative work on the important branch of industry with which it deals, as the authors are men practically in touch with the science and practice of metallurgy. The work is not only a valuable text book for all those interested in South African metallurgy, but also a useful guide book for all those engaged in other parts of the world under a similar or somewhat similar condition. The work has also the advantage of being comprehensive, containing in compact and readable form a vast mass of information which could otherwise be obtained only by long and weary research among technical and other scientific papers. We understand that for some years past volume I. has not been easily obtainable, and hence the present issue obviously meets an insistent demand.

The Marketing Problem, How it is being Tackled in U.S.A. By E. T. Elbourne, A.M.I.Mech.E., Director of Marketing Investigation, Shaw, Wardlaw & Co., Ltd.

Marketing within the Empire is the question of the hour, and Messrs. Longmans. Green & Co., announce the publication early next month of a book dealing with the latest marketing methods pursued by our biggest competitor.

The author is known to a wide circle through his writings on industrial administration and costings.

The new book is the outcome of an extensive survey in America by the author during July, August and September of this year. It presents an informative outline of the whole range of marketing activities which are bearing such fruitful results there. The subject is treated in non-technical language throughout and the work aims at placing the British Manufacturer in such a position that he may readily weigh up for himself the significance of American practice and see in what direction (if any) inspiration is to be obtained from it.

OFFICIAL PUBLICATIONS FROM THE DEPARTMENT OF COMMERCE, WASHINGTON, U.S.A.

Cement in 1924. By E. F. BURCHARD AND B. W. BAGLEY. Price 5 cents.

Gold, Silver, Copper, Lead and Zinc in Nevada in 1924. By W. C. HEIKES. Price 5 cents.

Gold and Silver in 1924 (General Report) By J. R. DUNLOP. Price 10 cents.

A Review of the Literature Relating to the Normal Densities of Gases. By MARION SMITH BLANCHARD AND S. F. PICKERING. Price 15 cents.

Accidents in the California Petroleum Industry in 1923. By H. C. MILLER AND C. E. STEIDEL. Price 5 cents.

Red Iron Ore and Tetruginous Sandstones of the Clinton Formation in the Birmingham District, Alabama. By W. R. CRANE. Price 10 cents.

Mineral Resources of the United States in 1925. Introduction by FRANK J. KATZ. Statistics assembled by MARTHA B. CLARK. Price 20 cents.

Accidents in Metallurgical Works in the United States during the Calendar Year 1924. By WILLIAM W. ADAMS. Price 10 cents.

Analyses of Tennessee Coals. Price 15 cents.

Action of Sodium Sulphate in Synthetic Tanning Materials. By EDGAR WOLESENSKY, Chemist. Price 10 cents.

Die Head Chasers (For Self-opening and adjustable die heads). Price 5 cents.

Analysis of Synthetic Tanning Materials. By EDWARD WOLESENSKY. Price 5 cents.

Summary of Recent Surveys in Northern Alaska. By PHILIP S. SMITH, J. B. MERTIEGE AND W. T. FORAN.

Elimination of Waste, Dining Car China Ware. Price 5 cents.

Fabric Tension Meter for use of Air Craft. By L. B. TUCKERMAN, G. H. KEULEGAN, AND H. N. EATON. Price 10 cents.

Experimental Study of the Relation between Intermittent and Non-Intermittent Sector-Wheel Photographic Exposures. Price 20 cents.

Endurance Tests of Tires. By W. L. HOLT, Physician AND P. L. WARMELEY, Physicist. Price 10 cents.

TRADE OF SOUTH MANCHURIA.

The British Consul at Dairen reports that the total value of imports into and exports from South Manchuria during 1925 was £23,395,000 and £29,715,000 respectively. The leading contributors of imports (excluding indirect trade) were Japan, £16,182,000; the United States £2,526,000; British Empire countries, £2,236,000; Germany, £1,114,000; Belgium, £246,000; and France, £236,000. The United Kingdom's share of imports totalled £686,000, and comprised chiefly machinery, iron and steel, piece-goods and chemicals.

The principal exports included beans, beancake, bean-oil, coal, cereals, raw silk, pig-iron, and oil-seeds. The values of the shares of the chief recipient countries (excluding indirect trade) were :— Japan, £22,152,000; United States, £1,407,000; British Empire countries, £1,199,000; the Netherlands, £916,000; Netherland Indies, £806,000; and Germany, £346,000. The share of the United Kingdom in the export trade was valued at £1,119,000, the leading items being beans, bean-oil, and oil-seeds.

THE FORMATION OF NEGATIE IONS IN MERCURY VAPOUR.

By Walter M. Nielsen.

Abstract.

The method used is similar to that of Mohler. Electrons, projected along the axis of a tube between two plates were prevented from scattering by a magnetic field of 350 gauss parallel to the axis of the tube. Negative ions formed by the attachment of an electron to an atom or to a molecule were removed by suitable potentials applied to the side plates. The remainder of the current reached a circular plate at the end of the tube. With a small field between the side plates, the negative ion current was just barely observable (1×10^{-10} amperes). With higher fields the ion current increased enormously, approaching saturation when the potential difference between the side plates was increased to between 3 and 4 volts. In this report the ion currents were of the order of 9×10^{-9} amperes. The total current was of the order of 1×10^{-7} amperes.

The ratio between the negative ion and total current decreases with increase in the driving potential for low voltages, but increases at 2.7, 4.7, 5.5, and 8.8 volts. The decrease at low potentials is similar to the results of Mohler in other gases and vapours. The cause of the break at 2.7 volts is not known. The breaks at 4.7, 5.5 and 8.8 volts are believed to be associated with the electronegative properties of the mercury atom having an electron in a metastable orbit. The total current rises rapidly with increase in the driving potential and decreases at 4.9 and 6.7 volts.—*Physical Review.*

FORTHCOMING EVENTS.

ROYAL SOCIETY OF ARTS.

Monday, November 29, at 8 p.m.—(Howard Lecture). Professor Hugh L. Callender, C.B.E., M.A., F.R.S., "Recent Experiments on the Properties of Steam at High Pressure." (Lecture III.)

Wednesday, December 1, at 8 p.m.—(Ordinary Meeting). George Constantinesco, 'The Torque Converter." James Swinburne, F.R.S., will preside.

SOCIETY OF PUBLIC ANALYSTS.

The next meeting of the Society will be held on Wednesday, December 1, at the Chemical Society's Rooms, Burlington House, Piccadilly, W.1., at 8 p.m.

The following papers will be read :—

"Recent Advances in the Bacteriological Methods of Examining Food and Water." By W. G Savage, M.D., B.Sc.

"The Detection of Furfural in Vinegar." By E. B. Hughes, M.Sc., F.I.C.

"The Rapid Determination of Opium in Stomach Contents." By E. R. Dovey, A.R.C.Sc., F.I.C.

"A Rapid Method for the Sorting of Butters and Margarines." By C. H. Manley, M.A., F.I.C.

Six Candidates for admission to the Society will be ballotted for.

Informal Dinner.—Arrangements have been made for Members and their Friends to dine together at St. James's Restaurant, 178, Piccadilly (opposite Burlington House), at 6.30 p.m.

ROYAL INSTITUTION.

21, Albemarle Street, Piccadilly, W.1.

Saturdays, November 27 and December 4. —"Atmospheric Electricity,' by Mr. George Simpson, D.Sc., F.R.S., M.R.I. (Director of the Meteorological Office).

(Two Lectures.)

Synopsis of Lectures.

Sufficient observations have now been made in all parts of the world to lead to the conclusion that as a whole the surface of the earth always possesses a charge of negative electricity. At the same time because the atmosphere is a conductor of electricity, this charge is constantly passing from the surface into the upper atmosphere, giving rise to what is called the earth-air current. In spite of this constant loss of electricity from the surface, the average value of the surface charge remains unchanged. The first lecture will be devoted to considering the evidence on which these conclusions have been reached and the instruments and methods used in measuring the charge on the surface and the earth-air current will be demonstrated.

If a current of negative electricity is constantly passing upwards from the surface of the earth into the upper atmosphere there must be a return current of the same magnitude. Up to the present no evidence has been found of this return current, so that this has become the central problem of

atmospheric electricity. The second lecture will be devoted to considering the various attempts which have been made to solve this problem, and the conclusion will be reached that no satisfactory explanation has yet been given, aud that in all probability further discoveries in physics of a fundamental nature will have to be made before the problem can be solved.

GEOLOGICAL SOCIETY OF LONDON.

At the meeting on December 1st, 1926, *the following communications will be read :*

"The Geology of the Snowdon Massif (North Wales" By Howel Williams, B.A., M.Sc., D.I.C., F.G.S.

"On Old Red Stadstone Plants showing structure from Brecon (South Wales)." By Dr. Albert Heard, M.Sc., F.G.S.

INSTITUTION OF ELECTRICAL ENGINEERS.

Monday, December 6, at 7 p.m.—Discussion on "Notes on the Trend of Electrical Development in America and Canada." (Opened by Mr. Ll. B. Atkinson.)

Scottish Centre.—Tuesday, 30 November. Annual Dinner at the Grosvenor Restaurant, Glasgow.

CANADIAN PATENTS.

Claims Allowed.

Chloride Production.—Archibald J. MacDougall. Winnipeg, Manitoba, Canada. 2nd November, 1926. Filed 10th November, 1925.

The method of obtaining lithium chloride and potassium chloride from Alumino silicates such as lepidolite, spodumene, petalite and ambigonite, which consists in forming a mixture of the alumino silicate and carbon, preferably ground, and chlorine and heating the mixture to a temperature of from six hundred degrees C. to one thousand degrees C. iu a rotary furnace.

Calcium Arsenate.—The Brown Company, assignee of High Kelsea Moore, both of Berlin, New Hampshire, U.S.A., 2nd November, 1926. Filed 11th December, 1925. Serial No. 309,056.

Claim.—A process of forming calcium arsenate, which comprises forming arsenious acid by dissolving arsenious oxide with heat in water in the presence of a minute quantity of an alkali at a temperature sufficiently high to maintain substantially all the arsenic acid formed thereby in solution, then adding the arsenious acid solution thus produced, in finely divided state, to the constantly changing surface of an agitated mixture of calcium hydroxide in solution and bleach liquor, thereby producing calcium arsenate without the formation of arsenite of appreciable quantities of soluble arsenates.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

Latest Patent Applications.

27,681.—Adler, R., and Adler, O.—Method of removing germs from water. November 4th.

27,946.—Allgemeine Ges. fur Chemische Industrie.—Process for eliminating water from liquid sulphurous acid. November 6th.

27,947.—Allgemeone Ges. fur Chemische Industrie.—Process for eleminating water from liquid sulphurous acid. November 6th.

27,587.—Cassella & Co., Ges., L.—Dyestuffs. November 3rd.

27,660.—Flommer, A.—Manufacture of photo-printing composition. November 4th.

Specifications Published.

260,346.—Pope, Sir W. J.—Manufacture of pharmaceutical products.

237,912.—Chemisch-Pharmazeutische Akt. Ges., Bad-Homburg.—Process for the manufacture of medicaments containing bismuth.

260,382.—Newbery, G., and May & Baker, Ltd.—Manufacture of solutions of amino-aryldichloroarsines or amino-arylarsenious oxides.

248,319.—Gronstedt, K. F. O.—Methods of preparing a remedy for tuberculosis in men and animals.

Printed Copies of the full Published Specification may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

Abstract Published.

258,289.—Urea-formaldehyde condensation products.—I. G. Farbenindustrie Akt.-Ges, Frankfort-on-Main, Germany.

Urea-formaldehyde condensation products are formed in an aqueous solution in which pH is continuously maintained at a value between 4 and 7, preferably with the aid of a buffer compound; the water is then removed by evaporation, preferably in vacuo, while keeping the temperature, at least in the latter stage, below 50° C. Buffer compounds mentioned are mixtures of acetic acid and sodium acetate, of citric acid and sodium citrate, of chloracetic acid and trisodium phosphate, of mono- and di-sodium phosphates, of boric acid and sodium acetate, sodium bitartrate or potassium bioxalate. Generally from 2 to 3 molecular proportions of formaldehyde are employed for each molecular proportion of urea. The products may be hardened at a temperature of 50-100° C., and used for the production of plates ,prisms, lenses, etc. When employed in the production of lacquers, the solvent required, e.g., ethylene glycol mono-methyl or mono-ethyl ether or ethylene chlodhydrin, is advantageously addtd before condensation takes place. Examples are given.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

CHOLORSENE.

470,121.—All goods in Class 2.—The United Alkali Company Ltd., Cunard Building, Water Street, Pier Head, Liverpool. November 10th.

DIAMMONPHOS.

471,942.—Fertilisers.—I. G. Farben-Industrie Aktiengesellschaft, Mainzer, Landstrasse 28, Frankfort-on-Main, Germany. November 10th.

HORMONOXOID.

471,824.—A pluriglandular gland preparation, being a medicine for human use in the treatment of ailments arising from endocrine deficiencies. Oxo, Ltd., Thames House, Queen Street Place, London, E.C.4. November 10th, 1926.

KOVIM.

472,249.—All goods in Class 3.—James Ratcliffe & Sons, Ltd., Middle Hillgate Tallow Works, Stockport. Cheshire. November 10th.

SAGRALAX.

473,656.—Chemical substances prepared for use in medicine and pharmacy.—Arthur H. Cox & Co., Ltd., 93, Lewes Road, Brighton. November 10th.

CLARKE'S INDIAN LOTION.

471,534.—A medicated lotion for human use in the treatment of rheumatism.—Clarke's Indian Lotion, 2, Aston's Place, Dublin.

INTELLIGOL.

473,163.—Chemical substances prepared for use in medicine and pharmacy.—August William Vesterling, 107, Castle Street, Battersea Park, London, S.W.11. November 3rd.

FRENCHMAN is prepared to give Lessons in French Grammar and Conversation.—Write, " C," c/o *Chemical News*.

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"The Chemical News,
Merton House, Salisbury Square,
London, E.C.4 (England).

ON THE DETERGENT ACTION OF SOAPS.

By ROWLAND MARCUS WOODMAN.

(*School of Agriculture, University of Cambridge.*)

(*Continued from Page* 341.)

The sub-columns under the heading "solvent" indicate the volume of the hydroxyl compound added previous to titration. This volume was always sufficient to clear the soap solution but never in excess of the amount indicated by Table A (*i.e.*, the limit of solubility of the added substance was never exceeded). The figures in these sub-columns, reading horizontally, represent the continuous titration method already discussed, and the corresponding figures in the sub-columns of the last column are the solubilities of the solute so found.

A turbid in the first sub-column o fthe last column indicates insolubility, though if less of the hydroxyl compound had been added, a solubility might have resulted. This is well brought out in the case of the solubility of paraffin oil in phenol-soap solution (first two results, Table B). By the continuous titration method discussed, it was found that 100 c.c., of 5 per cent. soap solution plus 18 c.c. of phenol dissolved 4.36 c.c. of paraffin oil before turbidity resulted; addition of phenol to make a total of 28 c.c. intensified the turbidity already existing, so that the oil was now less soluble. This was shown by adding 28 c.c. of phenol to 100 c.c. of the soap solution and determining the solubility of the oil (2.9 c.c.. The conclusion is, that though 100 c.c. of 5 per cent. soap solution dissolve 57 c.c. of phenol (Table A), they are capable of dissolving only 18 c.c. of phenol *plus* 4.36 c.c. of paraffin oil, or 28 c.c. of phenol *plus* 2.90 c.c. of oil; so that though the presence of the phenol in all cases tried made the solution of paraffin oil possible to an appreciable extent, there was evidently a balance of soap, phenol and water giving an optimum solubility of oil.

It will be noticed that the addition of a phenol or hydrogenated phenol to soap solution causes appreciable solution of the oils used in general. Except in the case of cresylic acid, benzene was more soluble than paraffin oil. Hexalin and then phenol appeared the best aids to solution of para-

ffin oil; but here the results were liable to be misleading because of the very dilute solution (5 per cent.) of soap used; a change in the balance of soap to water would possibly have changed this order, for previous experiments have shown cresylic to be a very efficient aid to solution of paraffin oil (Woodman, *loc. cit.*).

The case of aniline is peculiar, for its solubility is definitely depressed by addition of the hydroxyl compounds.

The scope of the experiments already described was now extended; known amounts of the potassium oleate (containing 37.24 per cent. of moisture) and of the hydroxyl compound were placed in stoppered graduated cylinders and subjected to hand-shaking. The character and volumes of the resulting mixtures were noted, as also the behaviour on dilution with definite amounts of water.

Five c.c. of a mixture were taken and a definite amount of oil added from a standard burette; the resulting mixture was made up to certain dilutions with water to see if the mixture were totally soluble or not. By varying the amounts of oil added initially to the five c.c. of soap-phenol mixture and repeating the process, the amount of oil completely soluble on subsequent dilution was got within limits by a method of trial and error. Table C gives the average of two nearly equal volumes of oil, one of which is, and one of which is not, completely soluble on subsequent dilution; the ranges of dilution at which solubility occurred are also noted in Tables C and D; thus no distinguishing letter means the whole mixture was soluble when made up to 50 c.c. with water; (a), (b), (c) and (d) mean that the ranges of dilution where complete solubility occurred are respectively 50-100 c.c., 100-250 c.c., 250-500 c.c., and 500-1000 c.c.

TABLE C.

Name of Mixture:		Gm. of moist soap to c.c. Hydroxyl compound in Mixture:	Character of Mixture:	Volume of Mixture in c.c.	Dilution of 5 c.c. of Mixture gives:	C.c. of Benzene dissolved by aid of 5c.c.:	C.c. of Paraffin oil dissolved by aid of 5c.c.:	C.c. of Anthracene oil dissolved by aid of 5c.c.:	C.c. of Coal tar creosote dissolved by aid of 5c.c.:
Phenol	A	100 :200	Solution	299	Solutions	1.31	1.12	0.12	0.47
,,	B	100 :150	,,	249	,,	1.62	1.37	0.37	0.62
,,	C	100 :100	,,	199	,,	1.87	3.12	0.37	0.75
,,	D	100 : 50	Mixture	—	—	—	—	—	—
Cresols	A	100 :200	Solution	300	Solutions (b)	—	0.37(d)	0.12	0.39(d)
,,	B	100 :150	,,	249	,, (a)	—	1.12(d)	0.12	0.40(d)
,,	C	100 :100	,,	199	Solutions	—	7.12(a)	0.12	0.40(d)
,,	D	100 : 75	,,	174	,,	—	5.35(a)	0.20	0.37(d)
,,	E	100 : 50	Mixture	—	—	—	—	—	—
Hexalin	A	100 :200	Solution	300	Solutions	—	0.37	0.12	0.18
,,	B	100 :150	,,	250	,,	—	1.87	0.37	0.62
,,	C	100 :100	,,	199	,,	—	3.87	0.87	1.12
,,	D	100 : 75	,,	174	,,	—	4.87	0.87	0.90
Methyl-hexalin	A	100 :200	,,	300	Emulsions	—	0.12	0.12	0.12
,,	B	100 :150	,,	250	Solutions	—	2.37	0.12	0.12
,,	C	100 :100	,,	198	,,	—	2.67	0.12	0.20
,,	D	100 : 75	Mixture	—	—	—	—	—	—

It will be seen that the best substance for admixture with potassium oleate containing 37.24 per cent. of moisture for the purpose of aiding solution of paraffin oil is cresylic acid, the next best being hexalin. Solution of anthracene oil and coal tar creosote can be obtained to a limited extent, particularly with the use of hexalin, but the volumes of these oils completely dissolved are relatively small compared with the amount of hexalin necessary.

In performing these later experiments the soap was mixed with the hydroxyl compound, first, because of subsequent ease in solution on dilution and, secondly, because of a possible complication which might have arisen in the light of the results quoted from Pickering's work; as one of the chief aims in the present experiments has been to measure the volumes of oil completely soluble on subsequent dilution without entailing any emulsification, it will be seen that the aforementioned factor (b) has been avoided. Not so factor (a).

A new series of experiments was made to test the effect of factor (a): to 5 c.c. of the soap-hydroxyl-compound mixtures (see Table C), water was added in definite quantity. The amount of oil totally soluble in the resulting mixtures on subsequent dilution with water was now determined by the method of trial and error previously described, the results being quoted in Table D:

result from that of Pickering's with soap solution itself (*loc. cit.*); much greater dilution of the mixtures, however, previous to admixture with the oil, makes them less efficient as oil solvents. Factor (a) plays a restricted role, therefore, when phenols or hydrogenated phenols are added to the soap.

DISCUSSION OF RESULTS.

It has been shown (Woodman, *loc. cit.*), that cresylic acid soap, besides being antiseptic, has much greater solvent and emulsifying actions for oil than ordinary soaps and must, therefore, be a better detergent agent. Heaton (*J. Oil and Colour Chemists' Assoc.*, 1923, VI., No. 39), states that hexalin soap, also on account of its solvent and emulsifying actions, is a very good detergent agent. Thus "badly soiled fabrics like greasy overalls can be cleaned . . . . without resorting to the use of alkalies" by hexalin soap. The incorporation of hydrogenated phenols in soaps also shortens the

TABLE D:

Name of Mixture:	Amount taken (c.c.):	Amount of Water aded (c.c.):	Description of Resulting Mixture:	Amount of Paraffin Oil Totally Soluble on Subsequent Dilution (c.c.):
Phenol C	5	0	Clear Solution	3.12
,,	5	1	,,	3.05
,,	5	2.5	,,	3.12
,,	5	5	,,	3.12
,,	5	45	,,	<1
Cresols C	5	0	,,	7.12(a)
,,	5	1	,,	6.87(b)
,,	5	2.5	,,	6.87
,,	5	5	Cloudy and Stiff	7.12
,,	5	45	Clear Solution	<2
Hexalin C	5	0	,,	3.87
,,	5	1	,,	3.70
,,	5	2.5	,,	3.85
,,	5	5	,,	3.86
,,	5	45	,,	<1
Methyl-hexalin C	5	0	,,	2.67
,,	5	1	Cloudy	2.75
,,	5	2.5	Cloudy thin "mucilage"	2.95
,,	5	5	Cloudy thick "mucilage"	2.12
,,	5	45	Clear Solution	<1

The mixtures used all contained 2.5 gm. of potassium oleate (containing 37.24 per cent. of moisture), in 5 c.c. (Table C.). Previous dilution of these mixtures with equal volumes of water (so that 1.57 gm. of anhydrous soap was now present to about 6 c.c. of water), did not affect very greatly the amount of paraffin oil capable of being put into solution; this is quite a different

process of soap making (Schrauth, *Zeitschr. der Deutschen Ol u. Fett Ind.* 1921, p. 37). The present results demonstrate that hexalin soap solution is a moderately good solvent for heavy oils such as anthracene and coal tar creosote, though not so good as cresylic acid soap in the case of paraffin oil. Hexalin soap, therefore, should be an excellent detergent agent; moreover, as the pro-

nounced acid and corrosive actions of the phenols are missing from the hydrogenated phenols, which are neutral in character and have properties similar to alcohols of high molecular weight (Heaton, *loc. cit.*) soaps made by their aid can be used for fabrics liable to injury by phenol soaps.

Pickering (*loc. cit.*) did not discuss to the full the fact that the more concentrated the soap solution the greater the solvent action per unit of soap. From his results, one may argue that the correct mode of washing an article (such as the skin or a fabric), is to moisten the article, rub with soap, scrub, and then rinse, instead of rubbing the article with soap under water—or with excess water—as most people do (as often in washing the hands); greater solvent action is thus assured, besides a greater initial concentration of oil. That this is recognised of importance by some soap firms is obvious from the label on some soaps; thus on one is the direction, " Rub the dry soap on the moist flannel or brush. *Don't* put the soap in the water—it's wasteful." Pickering's results, the author ventures to suggest, provide an explanation.

It is thus obvious that milled soaps and toilet soaps, which contain little water, will be more effective detergent agents than soaps containing more water. The above facts, however, are shown in this paper to be not of so great importance in the case of soaps containing phenols or hydrogenated phenols (Table D.).

The presence of hydrogenated phenols or phenols also makes soaps much more soluble, and more easily soluble, in water, yielding bright clear solutions; a 1 per cent. solution of a soap is turbid, but addition of small quantities of the mentioned substances clears the turbidities immediately; heat and stirring have to be resorted to in order to dissolve (soft) soaps, but a mixture of one of these substances with (soft) soap dissolves on pouring into water. These factors tend to increase the detergent action of soaps.

Finally, besides possessing greater solvent and emulsifying powers for oils than soaps, solution and emulsification of oils is much more rapid and easy, thus tending to increase detergent action. Thus pouring a mixture of oil, soft soap and one of these substances, made as described, into water, means immediate solution of the oil if in the correct proportions, or practically immediate emulsification (so-called " miscible " oils in horticultural practice), if the oil is in excess. Two further experiments also proved this point: in each case 5 gm. of anhydrous fish-oil soft soap were mixed with 100 gm. of paraffin oil, and left a year on the oven-top, occasional vigorous shaking being given. After this time, in neither case was solution complete; addition of 5 gm. of cresylic acid to one flask's contents, however, then caused solution of the soap in the oil in less than a day.

It should be noticed that the effect of the solubilities of oils by soaps on the detergent action of the soaps appears to be only of importance when " dirt " is due to hydrocarbon oils; true oils are, apparently, not soluble in soap or phenol-soap solutions.

ON THE SYNTHESIS OF ELEMENTS.

By F. H. Loring.

Whether it is possible or not to form certain elements out of others in the X-ray tube is a problem on which I have been engaged for some time. I made up a mixture of Rb, Te, Ni, Ca, Mo, potassium phosphate, and manganese sulphate . All of high purity. Traces of Zn may have been present, as an impurity common to some of the ingredients; but, in the experiments outlined here no Zn lines were observed except in the possible single case of one line. The Mo was taken from the same metal as used by Messrs. A. Hilger, Ltd., for their Mo anticathodes. This mixture, and one other mentioned below, was introduced into an X-ray tube and the spectrum lines recorded.

The apparatus employed consisted of a Shearer X-ray tube and Müller spectrograph with rocksalt crystal. Ilford X-ray plates used . Exposures, 9 hours each time. Current 5 to 8 milliamps. Voltage, 60,000. Mechanical pump (backing) and Hg-vapour pump used. Cathode Al. Anode formed by the brass head of the tube and the anticathode. Anticathode Cu, on which the above mixture (and afterwards one other, mentioned below) as a damp or wet powder was pressed. All parts of the tube water-cooled as usual. Slit-jaws (brass) set to 0.1 mm.

A number of negatives were obtained which gave, practically all the expected lines, in total about 10 per plate, with the ranges of exposure employed. In addition

to the normal spectra (sharp and clear) unusual lines appeared which were seemingly identifiable as follows :—

$75 L a_1 \lambda = 1.4294$ (the 2nd order $K a_1$ line of Mo is not near enough to account for this line, but it may be the $K a_1$ line of Zn, though it did not agree with a faint Zn$K a$ line on a comparison plate); Pt$L a_1 \lambda$ = 1.3114; Ru$K a_1 a_2 \lambda$ = 0.6439; Ru$K \beta_1 \lambda$ = 0.5724; Yb$L a_1 \lambda$ = 1.665 (Ni$K a_1 a_2 \lambda$ = 1.656, which is the measured value on the same plate); 2nd order I$K a_1$ and I$K \beta_1$ (see below). The above are the measured values in Angström units which agree very well with the true wave-lengths, these being —1.4298; 1.31008; 0.64371; 0.574; 1.6678; 1.6565. Exception might be taken to "0.574" as 0.572 is a nearer true value.

The suspected Yb line appeared on several plates, and being close to the strong Ni$K a_1 a_2$ line its wave-length was seen to be in the correct position, but it was faint. It was strongest on one later exposure (λ = 1.669) with only Kahlbaum's pure Rb and fairly pure Mn on the anticathode, in which case the line—the only "new" one obtained with this mixture—was nearer to the middle of the range of oscillation than before, when it was at one extreme. On still another plate it measured λ = 1.670. Averaging these three values gives a wave-length of 1.6680.

The Ru$K a_1 a_2$ lines (not resolved) were of moderate strength, and they were of about the right intensity relative to that of the Ru$K \beta_1$ line.

All measurements were made with the photo-measuring micrometer. The normal lines agreed with the proper values without appreciable error. The lines in question were re-measured several times to make sure that no mistakes had been made. It must be remembered that the *measured* wave-lengths are not reliable in the 4th place of decimals, and a slight variation in the 3rd place is possible when the lines are faint and difficult to measure accurately. The range of exposure was such as to make it possible to detect the presence of likely impurities, such as Hg, of sufficient amount to give very faint 2nd order lines. No misrepresentations can be traced to this cause. The stronger lines, of course, appear first.

The 2nd order iodine lines, however, are particularly doubtful, mainly because the 1st order lines did not appear for some reason. The 1st order Te lines did not appear either, though the oscillation was supposed to include them with a little margin to spare. Second order Te lines were identifiable with difficulty. The faint I and Te lines are therefore very uncertain. Volatibility may explain the difficulty of getting a proper spectrum of Te, as many compounds of Te boil at a comparatively low temperature. Te was in the original mixture, I was not. No other "new" or "stranger" lines appeared; that is, those which could not be identified with the elements above.

It would seem that the elements represented by the lines here listed could be made up as follows.

Element.	Isotopes (mass numbers).				At. Nos.
Rubidium	85	87			37
Molybdenum	96	96			42
Dvi-Mn (75)	181	183			79 - 4 = 75
Rubidium	85	85	87		37
Rubidium	85	87	87		37
Ytterbium (70)	170	172*	174		74 - 4 = 70
Nickel	58	60	58	60	28
Calcium	40	40	44	44	20
Ruthenium (44)	98	100	102*	104	48 - 4 = 44

Rubidium	85	87	85	87			37
Calcium	40	40	44	44			20
Iodine (53)	125	127 *	129	131			57 - 4 = 53
Tellurium	126	128	130	130	130	130	52
Zinc	64	64	64	66	68	70	30
Platinum (78)	190	192	194	196 *	198	200	82 - 4 = 78

NOTES.—The isotopes of Mo are not known so that the values 181, 183, may be collectively too low, though it is possible for a drop in the atomic-weight curve, as in the case of I relative to Te, and to a lesser degree Br relative to Se (see *Chem. News*, 1926, Vol. CXXXII., pp. 311 and 407—Note V.). The asterisk indicates about where the chemical atomic weight (mean isotopic value) falls. Iodine is a most uncertain condensation product as the lines present difficulties as stated above, and the extra isotopes do not appear to exist, but the process of original make-up according to the present possible view, may have then involved atoms (isotopes) differing in available amounts from those now available according to the scheme. The isotopes of Pt are not yet known experimentally. There is the possibility of other combinations, *e.g.*, Mo + 6H = Ru. In this case the above rule applies apparently thus :—

Element.	At. Wt.	At. Nos.
Molybdenum	96	42
6 Hydrogens	6	6
Ruthenium (44)	102	48 - 4 = 44

This seems possible because there were no Mo lines on the negative, and the strength of the lines indicated an appreciable amount of Ru formed.

Some of the agreements were very exact, while others (I ? and Te ?) were out a little. I have not been able to repeat all the "new" lines as the conditions under which they appear are evidently fugitive. Whenever there has been more than one line per element identified, as above, they have been on the same negative.

More work is obviously necessary to prove that any elements can be formed in the tube as the X-ray lines would seem to indicate.

These experiments were carried out in Messrs. Adam Hilger's Research Laboratory, London, under my direction. The X-ray work was done by Mr. T. D. Threadgold, of the firm's technical staff. Dr. Simeon, also of the staff, kindly gave valuable assistance.

SUMMARY.

An attempt is made to form elements synthetically in the X-ray tube by subjecting known mixtures to cathode-ray bombardment. There is some indication that atoms condense under the influences within the tube and form elements not in the original mixture, as instanced in the case of Mo + 6H = Ru, since an X-ray spectrum has been obtained pointing to this possibility; but more work is necessary to prove that this is the case. The rule suggested, as a trial one, is that the masses of the atoms which condense are additive, and also their atomic numbers, but from the latter summation 4 has to be subtracted. The results cannot always be repeated, but the $L\alpha_1$ line of Yb, apparently, appears frequently with mixtures containing Rb, suggegsting that a portion of the Rb atoms condense according to the above rule, the isotopes agreeing with known values. The make-up of the mixture is no doubt important, as only certain combinations are possible. This is a continuation of the work described in the *Chemical News* of May 14, 1926, page 311.

General Notes.

BRITISH INDUSTRIES FAIR FULL.

Minister on New Business Confidence.

Coming Trade Push.

It was officially announced in London last week, that the whole of the space in the British Industries Fair, which is to be held simultaneously in London and Birmingham from February 21 to March 4 next, had been taken with the exception of a few spaces rendered vacant in the Birmingham section by extensions of the Castle Bromwich premises.

"No more applications for space in the London section at White City, Shepherds Bush, can be considered," an official of the Department of Overseas Trade stated. "Space has been snapped up at the rate of 1,200 square feet a day lately, and the space asked for is well in excess of what is available.

"In the Birmingham section, which is being organised by the Birmingham Chamber of Commerce for the hardware, building, engineering, electrical and other 'heavy' industries, booking of space has exceeded by 25,000 square feet the total space available in the 1926 display, which itself beat all previous records."

FUEL BRIQUETTING.

Despite the many attempts to produce a suitable adhesive, the only successful method (from a commercial point of view) so far, is the medium soft gas tar pitch. The pros and cons of this method are well known, and as the latter outweigh the former, it is obvious why such steady efforts are being made to find a substitute. It would appear that something in this nature is being shortly marketed; after severe tests; and carrying with it a well-known engineer's report.

It is considerably cheaper than pitch, and the prices of the materials used are not subject to the constant changes in price that occur in the pitch market, and moreover, the ingredients are plentiful and easy to obtain.

The binder is tough and rubbery; and when powdered will remain in that condition much longer than powdered pitch, and fine dust clouds are eliminated. The melting point is higher than pitch although a high temperature is not necessary, and super-heated steam is used in mixing. The fuel sets out quickly and can be stacked and shipped as soon as manufactured.

The fuel made with the binder is not smokeless, but it is less so by three-fourths than pitch bound fuel: is waterproof and weatherproof; clean to handle, and does not soften on the fire.

A CLEARING HOUSE FOR SOURCES OF INFORMATION.

As a result of successful conferences which have been held annually for the past three years, the Association of Special Libraries and Information Bureaux has been formed and is now in process of incorporation. The Council cordially invites the support of all organisations and bodies, commercial houses, industrial concerns, etc., which attach adequate importance to the collection, treatment and dissemination of information relevant to their work.

Membership is open to all interested bodies, and a small subscription of £2 2s. per annum has been fixed. Further details, including a form of application and a list of members will be furnished by the Secretary, 38, Bloomsbury Square, London, W.C.1. To ensure its establishment on an adequate scale, not less than 500 members are required by March, 1927.

The offices are at 38, Bloomsbury Square, London, W.C.1.

TWO MORE HYDRO-ELECTRIC ENTERPRISES FOR OTTAWA DISTRICT (CANADA).

The directors of the Ottawa River Power Company are considering the installation of two additional units of 25,000 horsepower each at their Bryson plant on the Ottawa River about 50 miles above Ottawa. This would bring the installed capacity up to 75,000 horse-power. Mr. Nesbitt, President of the Company, stated that the outlook for business was good and he is optimistic enough to believe that the whole of this power would be sold within a reasonable time.

Coincident with the above statement comes a report that the Canadian Interna-

tional Paper Company are planning the development of 40,000 horse-power at the Mountain Falls on the Red River, which joins the Ottawa River about fifty miles below Ottawa.

AN EXTENSION OF THE QUEBEC COPPER ORES IN ONTARIO.

The Natural Resources Intelligence Service at Ottawa reports that working in the belief that the Quebec copper zone would be found to extend across the boundary into Ontario, prospectors have been showing unusual interest in the country lying between Larder and Abitibi lakes. Stakings are reported in five townships of Ontario lying along or near the inter provincial boundary. These are Marriott, Ben Nevis, Clifford, Pontiac, and Tannahill. In Marriott, a copper sulphide deposit is reported, and a number of parties have been staking claims.

TALC DEPOSITS IN CANADA.

Canada possesses one of the most important high-grade talc deposits in the world. This deposit, situated near Madoc in Hastings county, Ontario, has been the principal source of talc for the manufacture of talcum powder in both Canada and United States for a number of years.

Talc occurs in several forms and is characterised by properties that render it useful for a great variety of purposes. The most valuable type is a white variety of sufficient purity to be used in toilet preparations. The principal deposit in the Madoc area is a crumpled mass of white flaky talc schist, 1,300 feet long and from 5 to 65 feet wide, developed in dolomite not far from an intrusive mass of granite. Most of this deposit is owned by the George H. Gillespie Company, which operates a grinding plant at Madoc, the remainder belonging to the Asbestos Pulp Corporation. The total production of ground talc from the Madoc properties in 1925 was 13,678 tons, valued at $174,116. Formerly all that was not marketed in Canada was sold in the United States, but since the imposition of the Fordney tariff considerable amounts are being shipped to the United Kingdom, Germany, and other countries.

Grey talc schist ,suitable for use in ground form as filler in paper, in dusting rubber and for other purposes, for which a pure white colour is not essential is found in the Lage property near Victoria, B.C., near Anderson Lake, on the Pacific Great Eastern Railway, B.C.

MISHAPS.

A report received from Paris on the 28th ultimo, stated that a short circuit in an hotel in the Rue de Chalon, near the Gare de Lyon, started a fire, which spread to the staircase, and prevented people from leaving. Through the fire, some of the occupants of the bedrooms jumped from the windows, while about twenty other residents were rescued by the firemen. The same day an account was published of a disastrous fire which occurred at Bilston early the previous morning, when the Lion Hotel was found to be on fire about 2 a.m. The origin of the disaster, " it is thought, was the fusing of an electric wire." All the people in the place were rescued. The investigation by a mouse of the switchboard at the Woking Electricity Works recently caused a " short " which put all Byfleet users of electricity into darkness, caused them much inconvenience, and occasioned the death of the mouse. It does not take much to produce an interruption of an electricity supply.—*Gas Journal.*

BIG COPPER-LEAD-ZINC DEPOSIT BEING EXPLORED.

The Natural Resources Intelligence Service at Ottawa reports that through the efforts of Mr. Joseph Errington, of Toronto, a Director of McIntyre Mines, Limited, a new copper-lead-zinc field may possibly be opened up near Sudbury, Ontario. Modern mining methods in this case seem to have triumphed over those of a quarter of a century ago and with the aid of the diamond drill, with more attractive prices for lead and zinc and with improved metallurgical processes, a large mine would appear to be in the making on ground which previously appeared unattractive.

MICA.

According to finally revised statistics just issued, shipments of Canadian mica during 1925 amounted to 4,020 tons, valued at $261,463. In 1924, the total production was 4,091 tons with a value of $357,272. The quantity of scrap mica marketed showed a considerable increase to a total of 3,540 tons or 130 tons in excess of the sales in 1924.

ANTIMONY.

Antimony ores occur in the provinces of Nova Scotia, New Brunswick, British Columbia, and the Yukon Territory. During the first half of 1926, 76 tons, valued at $380, were shipped from the Lake George district of New Brunswick.

TRADE OF DAIREN IN 1925.

The gross value of the trade of Dairen increased from 249 million Haikwan taels in 1924 to 284 million H. tales in 1925—a substantial growth which, however, was due almost entirely to an expansion of the coasting trade, states the British Consul at Dairen. As regards the direct foreign trade, imports and exports were valued at 77.09 million taels and 129.20 million taels last year, as against 77.16 million taels and 125.70 million taels respectively in 1924. As regards trade with Chinese ports, imports (excluding goods subsequently re-exported to foreign countries) totalled 34.75 million taels, while exports were valued at 42.47 million taels. In 1924 the respective totals were 26.99 million taels and 19.37 million taels.

NATURAL GAS AND PETROLEUM WELLS IN CANADA.

The Mines Branch of the Dominion Department of Mines at Ottawa has just issued a revision of its list (No. 5) of Natural Gas and Petroleum Wells in Canada.

Copies of the list may be obtained by parties interested on application to the Natural Resources and Industrial Information Branch, The Canadian Building, Trafalgar Square, London, S.W.1.

GOLD PRODUCTION.

The total production of gold in Australia within the 40 years following the discovery, that is, from 1851 to 1891, was £298,688,000 of which Victoria alone contributed £229,788,000. The total production of California to the end of 1923 was £384,605,400, of which the placers yielded 68.64 per cent. During the first 13 years, the Golden Age, the total output was £129,621,250. In recent years the dredges had yielded 91 per cent. of the placer gold, which had itself represented 45 per cent. of the total production of the State. The wonderful yield of the early days, in California and Australia, came from alluvial deposits an economic cream that was quickly skimmed. It should be noted that the perform ance of the Victorian mines, both as to maximum production in one year, and as to aggregate output for 40 years, ran parallel with that of California. Some of the total outputs to the close of 1925 were as follows :—

	£
California	360,000,000
Victoria	302,000,000
New South Wales ...	62,433,308
Transvaal	843,600,850
Western Australia ...	155,000,000
Queensland	85,190,579

It would be noted that New South Wales, where gold in Australia was first discovered, failed to keep step with Victoria and California, and that the combined outputs of these two had been largely exceeded by the Transvaal, which now produced more than half the world's supply of the precious metal. The gold production of the world was now at the rate of £75,000,000 per annum, of which 80 per cent. came from regions under the British flag. This fact was of no small consequence during the Great War, for, as the gold of California and Nevada helped to save the American Union in the Civil War 65 years ago, so the gold of the Rand aided Britain during the great struggle recently undergone and during the economic readjustment that followed that appalling catastrophe.—*T. A. Rickard, Institution of Mining and Metallurgy.*

WHOLESALE PRICES IN FRANCE, BELGIUM, GERMANY AND ITALY.

Wholesale prices in France and Belgium increased in September, when the general inde xnumbers were 804 and 859 respec- index numbers were 804 and 859 respec- 785 and 836. A slight decrease was recorded in the German wholesale index, while the general price-level in Italy at the end of September was about 1.2 per cent. below the level on 31st August.

PROCEEDINGS AND NOTICES OF SOCIETIES.

ROYAL SOCIETY.

Thursday, December 2, 1926, at 4.30 p.m. The following papers were read :—

Optical Rotatory Dispersion, Part III. The Rotatory Dispersion of Quartz in the Infra Red, Visible and Ultra Violet Regions. By T. M. Lowry, F.R.S., and W. R. C. Coode-Adams.

Structure in the Secondary Hydrogen Spectrum. V. By O. W. Richardson, F.R.S.

General Forms of Statistical Mechanics with Special Reference to the New Quantum Mechanics. By R. H. Fowler, F.R.S.

On the Rate of Maximum Activation by Collision for the Complex Molecules with Applications to Velocities of Gas Particles. By R. H. Fowler, F.R.S., and E. K. Rideal.

The Spectrum of Fluorine (FI). By H. Dingle.

The following papers were read in title only :—

Integrals of the Equations of Electrodynamics with an application to the Electric Constants of a Transparent Medium. By H. M. Macdonald, F.R.S.

The Forces on a Cylinder in a Stream of Viscous Fluid. By L. N. G. Filon, F.R.S.

The Structure and Origin of the Swan Band Spectrum of Carbon. By R. C. Johnson.

Studies upon Catalytic Combustion. III. By W. A. Bone, F.R.S.

Absorption Spectra of Pyrone Derivatives in the Near Infra Red. By A. Ross.

An Analysis of the Electromagnetic Field into Moving Elements. By S. R. Milner, F.R.S.

The Structure of γ-Brass. By A. J. Bradley and J. Thewlis.

The Secondary and Tertiary Cathode Rays produced by External and Internal Absorption of Homogeneous X-rays. By H. R. Robinson and A. M. Cassie.

The Vapour Pressure and Melting Points of Sodium and Potassium. By W. Edmondson and A. Egerton, F.R.S.

The Chemical and Other Thermal Constants of Sodium and Potassium. By W. Edmondson and A. Egerton, F.R.S.

The Thermal Conductivity of Vitreous Silica with a Note on Crystalline Quartz. By G. W. C. Kaye and W. F. Higgins.

On Hilbert's World-Function. By E. T. Whittaker, F.R.S.

On Wireless Interference Phenomena between Ground Waves and Waves Deviated by the Upper Atmosphere. By E. V. Appleton and M. A. F. Barnett.

An X-ray Study of Isomorphism in Simple Organi-metallic Serier. Part I. The Tetraphenyls. By W. H. George.

Conduction of Heat through Powders and its Dependence on the Pressure and Conductivity of the Gaseous Phase. By J. Aberdeen and T. H. Laby.

Supplementary Tables of Wave Lengths of New Lines in the Secondary Spectrum of Hydrogen. By D. B. Deodhar.

The Equilbrium of Heterogeneous Systems including Electropytes. Part II. Equilibrium at Interfaces and the Theory of Electrocapillarity. By J. A. V. Butler.

A Further Note upon "Inter traction." By N. K. Adam.

On the Form and Energy of Crystalline Sodium Nitrate. By J. Topping and S. Chapman, F.R.S.

THE FARADAY SOCIETY.

The following paper was read at the meeting held on October 27, 1926 :—

Condition of Silver Chromate in Gelatine From Electric Conductivity and Diffusion Experiments. By A. C. Chatterji and N. R. Dhar.

In foregoing papers it has been shown that the concentration of silver nitrate necessary to turn a yellow sol of silver chromate in gelatine red, goes on increasing as the concentration of the yellow sol decreases. Moreover, the solubility product of silver chromate goes on increasing as the concentration of the gelatine gel increases and this product, instead of keeping constant for the same concentration of gelatine, goes on decreasing as the concentration of the yellow sol of silver followed the ordinary rules of solubility product, as has been assumed by Williams and Mackenzie, this product should have been constant, but it is not so. Hence we have concluded that the ordinary solubility relations do not apply to these cases of peptisation.

Moreover, we have shown that the yellow sol of silver chromate is negatively charged owing to the preferential adsorption of chromate ions and when the yellow sol is changed to red by the addition of silver nitrate, the change of colour is accompanied by a reversal of the charge. The red sol of silver chromate is positively charged due to the adsorption of silver ions. We are of the opinion that the red sol is more unstable than the yellow one.

We have found out that the amount of silver chromate (solubility product) that can remain in suspension in 5.67 per cent. gelatine has the value 3.38×10^{-7}. Comparing this value with the solubility product of silver chromate in water at 29° (4.2×10^{-12}), we get the ratio 8.04×10^{4}.

Hence our experimental results show that large quantities of silver chromate can exist in the peptised condition in gelatine.

Further evidence in favour of the existence of silver chromate in the colloidal state is brought forward in this paper by measuring its electric conductivity in gelatine.

Experiments were undertaken to find out the conductivity of silver chromate of different concentrations in 3 per cent. gelatine at 35°. As silver chromate was produced by the addition of equivalent quantities of silver nitrate and potassium chromate to the gelatine, an equivalent amount of potassium nitrate was simultaneously produced. In order to ascertian the conductivity of silver chromate alone, the conductivity of an equivalent concentration of potassium nitrate alone in gelatine was determined under identical conditions.

A typical result of conductivity experiments is shown in Table I. :—

TABLE I.

Concentrations of silver chromate, potassium nitrate, potassium chromate and silver nitrate used	N/520.
Conductivity of water at 35°	8.904×10^{-6} mhos.
Conductivity of gelatine at 35°	1.1868×10^{-3} ,,
Conductivity of gelatine and potassium chromate at 35°	1.4362×10^{-3} ,,
Conductivity of gelatine and silver nitrate at 35°	1.4187×10^{-3} ,,
Conductivity of gelatine ,silver nitrate and potassium chromate at 35°	1.4451×10^{-3} ,,
Conductivity of potassium nitrate in gelatine at 35°	1.4041×10^{-3} ,,

Exactly similar results were obtained with other concentrations of the electrolytes and the results obtained are summarised in Table II.

From the conductivity measurements given in Table I., the conductivity of silver chromate as determined by experiments can be ascertained by simply subtracting the conductivity of potassium nitrate from that of the mixture of potassium chromate and silver nitrate. If it is supposed that silver chromate remains in the ionic condition and not in the colloidal state, then its conductivity should be equal to the sum of the conductivities of potassium chromate and silver nitrate *less* the conductivity of potassium nitrate.

SUMMARY AND CONCLUSION.

(1) Measurements of electric conductivity of silver chromate of varying concentrations in gelatine show that the observed conductivity is much less than the conductivity calculated on the assumption that silver chromate exists wholly as ions in gelatine.

(2) Diffusion experiments show that chromate ions and not silver chromate diffuse in gelatine placed on the top of a gel containing silver nitrate and an equivalent quantity of potassium chromate.

(3) The chemical change between silver nitrate and an equivalent quantity of potassium chromate is not complete in presence of gelatine, an amount of potassium chromate remains free. An explanation of this behaviour based on the more marked adsorption of silver ions than that of chromate ions by gelatine, has been advanced.

(4) When silver salts are allowed to diffuse in gelatine gel containing silver chromate, rings are formed only when the concentration of silver chromate is within a definite limit.

(5) Potassium chromate can coagulate and change a yellow sol of silver chromate intto a red one when the concentration of silver chromate is nearer the limit at which it can remain yellow in the peptised condition.

(6) Experimental results of electric conductivity, on diffusion or on coagulation prove that silver chromate exists in pure gelatine mainly in the colloidal condition and that Liesegang rings are produced by the coagulation of this peptised substance.

THE PHYSICAL SOCIETY OF LONDON.

Proceedings at the meeting held on Friday, October 22, 1926, at the Imperial College of Science. Prof. O. W. Richardson, M.A., D.Sc., F.R.S., President, in the chair.

A Demonstration of Selenium Cells was given by Professor Thirring, Professor of Theoretical Physics in the University of Vienna.

The sensitivity of a selenium cell depends a great deal upon the thinness of the selenium coating, since only the surface layer is

influenced by the light. Experience has shown that with the condenser type of cells the thickness of the selenium coating can be reduced down to any desired value by the capillary action of suitably chosen electrodes. The condenser type is convenient also for making selenium cells of very small light-sensitive area, without unduly increasing the resistance.

The advantage of a small light sensitive surface lies in the fact that a focussing lens which concentrates the light on the cells can be used. Since the ratio between dark resistance and light resistance depends on the intensiy of illumination (energy per unit area), a small cell can be used more efficiently than a large one with equal electrical properties.

It does not seem to be possible to remove all the deficiencies which are naturally inherent in selenium cells. Among these deficiencies the following may be mentioned :

(a) The resistance is not a linear function of the intensity of illumination;

(b) It has a temperature coefficient;

(c) The reaction to light is not instantaneous.

Selenium cells should, therefore, be used in an arrangement which compensates as far as possible these deficiencies for the given purpose. A very efficient device is the use of the cells with an intermittent illumination of acoustical frequency, the cell being coupled with an amplifier. It is important in this case that there should be no spontaneous rapid fluctuatings of the resistance, for these give rise to grating noises. In this respect also the cells shown are superior to those of the grid type, because of the better electrical contact at the electrode.

One of the experiments shown illustrated an arrangement of this kind. The filament of a small 6-volt lamp was focussed upon a selenium cell with a sensitive area of 1 mm^2, by means of two lenses 4 cm. in diameter over the length of the lecture table. The light was interrupted by means of a phonic wheel rotating close to the lamp. The fluctuating current in the selenium cell was amplified and made audible throughout the theatre by means of a loud-speaker.

Another experiment illustrated the advantages of balancing two selenium cells in a Wheatstone bridge arrangement. By exposing the cells alternatively to illumination the balance was upset in opposite directions.

The Corrosion Products and Mechanical Properties of Certain Light Aluminium Alloys, as Affected by Atmospheric Exposure. By PROF. ERNEST WILSON

ABSTRACT.

The paper gives an account of experiments which have been made upon the electrical conductivities, the corrosion products and tensile properties of high purity aluminium, and certain light aluminium alloys, which have been exposed to London atmosphere for a period of 24 years. The variation of electrical conductivity, the growth of the corrosion product and its composition have been studied, and the tensile properties before and after exposure have been compared. Finally, there is a note on the corrosion products of high conductivity copper.

The Distribution of Intensity in a Positive Ray Spectral Line. By M. C. JOHNSON, M.A., M.Sc.

ABSTRACT.

The study of the optical spectra of positive rays is continued with the type of tube and Merton wedge described previously. The direction of observation is here longitudinal, in order to isolate the Doppler effect in the "moving" spectrum; accordingly a six-prism spectrograph is substituted for the echelon used with a narrower line in Part I. The results are added to those of Stark, Paschen, Wilsar, and Krefft on the same spectrum, and the uncertainties in identifying atomic and molecular carriers are analysed. The distribution of velocity among the particles contributing to the "moving" spectrum is compared with the distribution of velocity in positive rays measured by the electromagnetic method and with some investigations of Betschinsky and Döpel. The appearance of the many-lnes spectrum of hydrogen in the positive rays, and the ratio of intensity of the "moving" and "resting" spectra are also considered. The inverse square law of probability of electron capture, and some consequences of the work of Wien and Rüchardt, are the most likely controlling factors in the several phenomena.

Proceedings at the meeting, held on Friday, November 12, 1926, at the Imperial College of Science. E. H. Rayner, M.A., D.Sc., Vice-President, in the chair.

A Rapid Bolometer made by Sputtering on Thin Films. By H. DEWHURST, A.R.C.S., D.I.C., Imperial College of Science and Technology.

SUMMARY.

Thin Films. The method of making thin films of collodion by drying weak solutions in ether and alcohol on the surface of clean mercury, and their subsequent removal, is described. Flexible films are also made in the same way, using a modified formula, producing very robust films which withstand great distortion, and will stand being punctured without fracture. Both types can be produced rapidly and cheaply down to a thickness of one wavelength of light.

Sputtering.—Two novel types of sputtering apparatus are described, together with working data. A table is given containing sputtering data for 25 metals, nine of which appear for the first time. Notes relating to the effects of shape and age of kathode, shape of anode, form of dark-space and kathode temperature appear, together with novel modifications in the design of the Wehnelt break. Approximate temperature coefficients of resistance are assigned to eight new metals and more accurate values of three others, that relating to gold being new. The apparatus used for these determinations is described. Notes and curves on ageing appear regarding six metals and resistances for films of standard size for ten metals. A curve is given throwing, perhaps, some light on the formation of a sputtered film.

Bolometer.—Apparatus is described by which rings are moulded for supporting the thin collodion films and providing a reliable contact for overlying sputtered metallic films. The method of making the bolometers, together with holders of various types, and apparatus for blackening, are detailed. The comparative sensitivity of these new bolometers is discussed, and curevs and an empirical formula given from which an estimate of the speed of the instruments can be determined.

The new type is roughly 400 per cent. faster than a representative bolometer of the Lummer and Kurlbaum type. The thickness of the component metal film is estimated.

DEMONSTRATION.

The paper was illustrated by a demonstration designed to compare the speeds of the bolometer described and of an instrument of the Lummer and Kurlbaum type. The two bolometers were arranged in balanced bridges, so as to control two relays operating ignition circuits for exploding two charges of flash powder, and were simultaneously exposed to illumination.

The Effect of Working on the Physical Properties of Tungsten By J. W. AVERY, B.Ss., D.I.C., AND C. J. SMITHELLS, D.Sc. (A communication from the staff of the Research Laboratories of the General Electric Company, Ltd., Wembley.)

ABSTRACT.

Changes in the density and resistivity of tungsten during swaging and drawing have been investigated.

The densities of pure and thoriated tungsten (0.63) per cent. thoria) from the sintered bar down to wires 0.02 mms. in diameter are given. The experimental advantages of the use of benzene as the displaced liquid are mentioned.

Measurements of the densities of specimens cleaned in successive stages by etching reveal the presence of low density surface layers.

Variations of heat treatment likely to occur in practice are shown to have no appreciable effect upon the density of worked tungsten.

The density rises rapidly during swaging to a maximum value within 0.5 per cent. of the density of the perfect tungsten crystal. Further working produces a steady fall in density, which becomes more marked in the finest sizes.

Measurements have been made of the resistivity of the same specimens.

The resistivity falls rapidly in the early stages of working and reaches a minimum when the density is a maximum. It then increases at a uniform rate, which is approximately an expomential function of the diameter.

NOTICES OF BOOKS.

SOME RECENT GERMAN SCIENTIFIC BOOKS.

German publishing firms continue to issue a ceaseless stream of scientific books, not a few of them by men prominent in special branches of Science. In general these works maintain a high standard, especially does this seem to be the case with books dealing with Physical Chemistry and Biology.

The Gebrüder Borntraeger (Berlin) have just published an interesting volume dealing with the borderland of inorganic science and biology by H. PRZIBRAM, entitled *Die anorgischen Grenzgebiete der Biologie*, pp. 240, price 6 marks. The importance of

borderland studies is emphasised and well exemplified by the parallels the author draws from crystal development and dissolution and the phenomena of organised growth. Changes in inanimate matter may be watched with precision in such cases as polarisation, heteromorphosis, etc. Prof. Przibram concludes with a chapter on the value to be attached to crystal analogies.

Two other monographs have been published by the same firm: *Theorie der Adsorption von Gasen*, by Dr. E. Jaquet, pp. 56, price 5 marks. The author develops his theory of adsorption and gives an equation for the isotherms which rests upon the calculation of the probabilities. The energy of adsorption is stated to be dependent on the tangent of the isotherms. A relation is also derived connecting the electrical constants of molecules with the energy of adsorption. Many methods of testing the theory are given by the author, who points to the support all these afford to his views. In addition, the influence of the adsorbent is considered. Those engaged in this field of research will welcome the advent of Dr. Jaquet's monograph.

The other monograph from Geb. Borntraeger is *Über die Beweglichkeit der elektrolytischen Ionen*, by Hermann Ulich, pp. 56, price 4 marks 80 pf., and, like the one by Jaquet, is reprinted from the Fortschritte der Chemie, Physik und physikalischen Chemie. It deals with historical and recent work on the mobility of ions and forms a very useful summary of present day knowledge of the subject.

Julius Springer (Berlin and Vienna) has published—

(1) *Praktikum der Qualitativen Analyse*, by Rudolf Ochs, pp. 126, price 4 marks 80 pf.

(2) *Eiweisskorper und Kolloide*, by Prof. Wolfgang Pauli, pp. 32, price 4 schillings.

The first is intended for the use of medical and pharmaceutical students and has been framed with their requirements in view. The first is intended for the use of medical and pharmaceutical students and has been framed with their requirements in view. The plan of the work is to describe the general properties of the metal, its reactions in solution and connection and differences from the other members of the same analytical group. It contains one or two curious statements, *e.g.*, p. 25, HgS is soluble in *aqua regia* (Königswasser) in presence of air $HgS + 2HCl + 4O = HgCl_2 + H_2SO_4$. On p. 81 in "gelbe Zinn(2)-Sulfid" stannic (4) sulphide is meant. Prof. Pauli's book is based upon two lectures delivered to medical practitioners, biologists and chemists. The author endeavours to correlate the chemical and physical properties of colloids like egg albumen. He contends that all the phenomena must be taken into consideration in the outlining of any theory on the subject.

Theodor Steinkopff (Dresden and Leipzig) have recently published two interesting volumes on colloid chemistry.

(1) *Fortschritte der Kolloidchemie*, by Prof. H. Freundlich, pp. 109, price 5 marks 50 pf.

(2) *Ambronn Festschrift*, edited by A. Frey and Wo. Ostwald. Pp. 376. Price 18 marks.

The first is based upon lectures given in the United States, in which the author traced the recent advances in our knowledge of the colloidal state.

The second is a more substantial volume such as continental scientists prepare in honour of a distinguished man's jubilee (*cf.* the Brauner Jubilee number of the *Recueil des travaux chimiques des Pays-Bas*, May, 1925, reviewed in the *Chemical News*, vol. CXXX., p. 369). The contributors to the Ambronn-Festschrift are friends and students of Prof. H. Ambronn, who celebrated his 70th birthday on August 11. The contributions mostly deal with the micellar structure of colloids, the subject in which Ambronn has made notable advances and they record the results of their investigations in many branches of the study of the colloidal state. To give a list only of these contributors would occupy a column of this Journal. Suffice it to say that the volume is a credit to those responsible for its production.

Finally, further parts of Abderhalden's *Handbuch der biologischen Arbeitsmethoden* (Urban and Schwarzenberg, Berlin & Vienna) continue to appear. The latest, Abt. III. Physikalisch-chemische Methoden, Teil B, Heft 3, deals wth the precipitation of colloids and the estimation of the iso-electrical point. Prof. A. Fodor: Determination of Adsorption; Prof. F. V. von Hahn: Methods of Dispersoid Analysis; Dr. R. Riwlin: Structure of Colloid Micels and Prof. H. Bechhold: Ultra-filtration and Electro-utrafiltration complete this section.

J. G. F. D.

FORTHCOMING EVENTS.

ROYAL INSTITUTION.

21, Albemarle Street, London, W.1.

Saturday, December 4, at 3 p.m.—"Atmospheric Electricity," by George C. Simpson.

Thursdays, December 9, and 16, at 5.15 p.m.—1. "Early Medical Literature"; 2. "Medical Literature in Relation to Journalism," by Sir Squire Sprigge, M.A., M.D., B.C., F.R.C.S., Editor of the *Lancet*.

Saturday, December 11, at 3 p.m.—Dr. Cyril Rootham commences a course of two lectures, musically illustrated, on "Henry Purcell and his Contemporaries."

INSTITUTION OF ELECTRICAL ENGINEERS.

Scottish Centre.—North British Hotel, Glasgow.—Tuesday, December 7, at 7 p.m. R. B. Mitchell, "Home Lighting."

Dundee Sub-Centre. At University College, Dundee—Thursday, December 9, at 7.30 p.m. Prof. A. R. Fulton, D.Sc., "Tidal Power from the Tay."

East Midland Sub-Centre. At the College, Loughborough.—Tuesday, December 7, at 6.15 p.m.—Col. J. F. Lister, C.M.G.

ROYAL SOCIETY OF ARTS.

Wednesday, December 8, at 8 p.m.—(Ordinary Meeting.) Monsieur Van Cauwelaert (Burgomaster of Antwerp), "The Port of Antwerp."

Friday, December 10, at 4.30 p.m.—(Indian Section.) Cecil Henry Bompas, C.S.I., "The Calcutta Improvement Trust." Sir Edward A. Gait, K.C.S.I., C.I.E., Member of the Council of India, will preside.

OTHER MEETINGS.

Monday, December 6—

Society of Chemical Industry (L.S.).
Biochemical Society.

Thursday, December 9—

Institute of Chemical Engineers.
Oil and Colour Chemists' Association

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

28,664.—British Dyestuffs Corporation, Ltd.—Manufacture of dyes, etc.—November 13th.

28,311.—Bohme Akt.-Ges., M.—Sulphurising fatty acids ,etc. November 10th.

28,521.—Boedecker, F.—Preparation of vanillin and iso-vanillin. November 12th.

28,389.—Metallbank and Metallurgische Ges Akt.-Ges.—Method of simultaneously working up gas currents into sulphuric acid, etc. November 11th.

28,564.—Okochi, M.—Process of collecting benzene, etc., from coal gas, etc.

Specifications Published.

260,638.—Wylam, R., Harris, J. E. C., Thomas, J., and Scottish Dyes, Ltd.—Dyes and dyeing.

260,682.—Badische Anilin & Soda Fabrik.—Preparations suitable for developing baths for use in dyeing.

260,686.—Robinson, H. W., and Parkes, D. W.—Removal of tar acids from ammonia liquor and other liquors.

Printed Copies of the full Published Specification may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2., at the uniform price of 1s. each.

Abstract Published.

258,678.—Disinfectants.—Gordon, G. G., 7, Burnley Road, Dollis Hill, London. Disinfectants are prepared from eucalyp-

tus oils, or substances such as cineol, phellandrene, or piperitone extracted therefrom, by dissolving rosin, oleic acid, cotton seed oil, linseed oil or like saponifiable substance in the eucalyptus preparation and then adding an aqueous alkaline solution so as to form a saponaceous vehicle for the eucalyptus content which is adjusted to constitute approximately 37 per cent. of the final product. Eucalyptus oils specified are those obtained from Eucalyptus Phellandra, E. Australiana, E. elaeophora, and E. Sideroxylon. Small proportions of oil of Eucalyptus citrioda or oil of lemongrass are added to give the desired odour to the preparations.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

PIXIE.

473,633.—Dyes in Class I.—James Hall & Co. (Edinburgh) Ltd., 133, George Street, Edinburgh. November 17th.

CELLAPPRET.

473,809.—Chemical substances used in manufactures, photography, or philosophical research, and anti-corrosives. — L-G. Farbenindustrie Aktiengesellschaft, Mainzer Landstrasse, 28, Frankfort-on-Main, Germany. November 17th.

SYNOT.

471,484.—Medicated Bath Salts.—John Scott, 49, Old Broad Street, London, W.1. November 17th.

TRIMTHAL.

473,074.—All Goods in Class 3.—Donald George Mackenzie, 148, Parliamentary Road, Glasgow. November 17th.

KOVIM.

472,249.—All goods in Class 3.—James Ratcliffe & Sons, Ltd., Middle Hillgate Tallow Works, Stockport, Cheshire. November 10th.

SAGRALAX.

473,656.—Chemical substances prepared for use in medicine and pharmacy.—Arthur H. Cox & Co., Ltd., 93, Lewes Road, Brighton. November 10th.

CLARKE'S INDIAN LOTION.

471,534.—A medicated lotion for human use in the treatment of rheumatism.—Clarke's Indian Lotion, 2, Aston's Place, Dublin.

INTELLIGOL.

473,163.—Chemical substances prepared for use in medicine and pharmacy.—August William Vesterling, 107, Castle Street, Battersea Park, London, S.W.11. November 3rd.

FOR SALE.

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Journals of the Chemical Society, 1915, £1; 1924, 1925, 10s. each; also *Chem. Soc. Abstracts*, 1924, 1925, 12s. each. All complete with indices.

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A COMPACT AND COMPREHENSIVE SERIES OF REACTIONS AND TABLES CHEMISTRY.

By ROBERT SAXON, B.Sc., F.C.S.

(*Continued from Page* 809.)

SYNTHESIS OF CHEMICAL COMPOUNDS.

The simplest cases of chemical synthesis are those where two elements unite to form an "-ide," which we call ides. Some pairs combine spontaneously (sign), but most require heat to "open out" the molecules of each element. Once started, however, the heat evolved by union is sufficient to keep unjoined molecules opened out, and continue the reaction. As before, temperature needed to start is indicated in degrees centigrade, or suggested by t, etc.

i 2H/O /t HOH.
2H/O xxxx/st HOH.

Here explosion occurs (xxxx) when the mixture is sparked or ignited.

ii 2Li/O /t Li_2O, also Na, K. Rb. Cs.

iii Be/O /t BeO, also Mg, Ca, Sr, Ba, Zn, Cd, Hg.

iv 2B/3O /t B_2O_3, also Al, Se, Yt, La, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Ce, Ga, In, Tl.

v C/2O /t CO_2, also Si, Ti, Zr, Th, Ge, Sn, Pb

vi Pb/O /t PbO

vii (st(2N/3O → N_2O_3)st)
meaning in confined space, sparks being passed.

viii 2P/5O /wt P_2O_5
ix 4As/60 /t As_4O_6

x 2Sb/30 /rt Sb_2O_3

xi 2Bi/30 /rt Bi_2O_3

xii 2V/50 /it V_2O_5, also Cb, Ta.

xiii S/20 /t SO_2, also Cb, Ta

xiv S30 /t SO_3, also Mo, W

xv 2Cr/30 /it Cr_2O_3

xvi 3U/80 /it Cr_3O_8

xvii 3Mn/4O /it Mn_3O_4

xviii 3Fe/4O /rt Fe_3O_4, also Co.
Iron rust or Fe_2O_3 is never formed without the agency of water.

xix Ni/O /it NiO

xx Cu/O /rt CuO

xxi 2Rh/3O /rt Rh_2O_3

xxii Ph/O - 2Pdo (not complete)

xxiii .Os/4O /t OsO_4
The . preceding Os means finely divided.

SYNTHESIS OF FLUORIDES.

The most active element known is fluorine, which although like the halogens, also resembles oxygen. It is like a keystone between the two groups ike Li, Be, B, Au, Hg, Pb and Bi, which, taken in pairs, have much in common.

i Li/F it/- LiF, also Na, K, Rb, Cs, Cu, Ag, and H.

ii Au/3F /500d AuF_3.
Here a temperature of 500 degrees centigrade is necessary to start the reaction.

iii Be/2F it/- BeF_2
The "it" refers to the incandescent heat given out. It is a qualifying symbol, whereas n would be quantitative, referring to some number of big calories.
Also Mg, Zn, Cd, Ca, Sr, Ba.
Hg/F - HgF
HgF/F HgF_2

iv B/3F it/- BF_3, also all group III.

v C/4F it/- CF_4, also all group IV

vi P/5F it/- PF_5, also V, Cb, Ta, As, Sb

vii Bi/3F - BiF_3

viii F/O O/et or -t
This means no action (0 big cals), at the temperature of the electric furnace, or at the lowest temperatures available.

ix S/4F - SF_4, also Se, Te. All hydrolysed by water.

x S/6F - SF_6, also Se, Te, Cr, Mo, W, U

xi Mn/7F - MnF_7. Hyd. by water

xii Mn/3F - MnF_3. Also Br.

xiii I/5F - IF_5

xiv Fe/3F - FeF_3

xv Fe/2F - FeF_2, also Co, Ni, Cu, Pd.

The above and the density of the fluorides point to the fact that fluorine is as consistently monad as hydrogen, and these two have an intense affinity for each other, a determinant factor in the greater number of cases of hydrolysis of fluorides. The following examples, though not cases of synthesis are interesting, as they show the enormous strength of the negative side of fluorine. Note the ease s with compact molecules like carbon, silica, boron trioxide. Note in the case of silica, a most compact compound, both products are gases.

xvi P_2O_5/6F /rt PF_3/POF_3/4O

xvii PCl_5/5F it/- PF_5/5Cl

xviii C/4F it/- CF_4, but

xix CO/4F 0/fp.
No action at freezing point.

xx Pt/4F //500d PtF_4
Slow reaction (//) at 500 degrees centigrade.

xxi CaC_2/10F - CaF_2/2CF_4

xxii SiO_2/4F - SiF_4/2O

xxiii NH_3/3F xxxx 3HF/N

xxiv Na_2SO_4/2F /t 2NaF/SO_2/2O

xxv $NaPO_3$/6F - NaF/PF_5/3O
From these it would appear that SO_4 is a stronger anion than PO_3, phosphorus has greater affinity for fluorine than oxygen, and with sulphur the reverse.

xxvi Na_2O/2F it/- 2NaF/O

SYNTHESIS OF HALOGEN IDES.

Chlorine and oxygen are great rivals, both being ousted easily by fluorine. They replace each other and the trend of the reaction depends upon mass products, or the nescent character of the usurper.

i Na/Cl it/- NaCl, also other alkali metals.

ii Cu/Cl /t CuCl, also Ag. Also note

iii Ag_2O/2Cl /t 2AgCl/O

iv 2AgCl/S 0/bp.
No action even when boiled.

v $AgCl/Nam\ 0/$- (Sodium amalgam)

vi $AgCl\ //sl\ Ag/Cl$ (Sunlight)

vii $Cu/2Cl$ /t $CuCl_2$

viii $Be/2Cl$ - $BeCl_2$

ix $BeCl_2/2HOH$ - $Be(OH)_2/2HCl$

x $Mg/2Cl$ /t $MgCl_2$, also Zn, Cd, Hg

xi $2KCl/Mg$ /t $MgCl_2/2K$, also chlorides of Li, Na, Rh, Cs, Ca, Sr, Ba, Zn, Cd, Hg, Cu, Ag, Al, Tl, Sn, Pb, As, Sb, Bi, 6th, 7th, 8th groups.

xii $Ca/2Cl$ - $CaCl_2$, also Sr, Br

xiii $Al/3Cl$ /t $AlCl_3$, also every known chloride of this group, including La, etc. Also B.

xiv $BCl_3/3HOH$ xx $B(OH)_3/3HCl$ (rapid reaction at ordinary temperature)

xv $2Si/6Cl$ /t Si_2Cl_6

xvi $Si/4Cl$ /t $SiCl_4$, also all group except C. Hydrolysed

xvii $P/3Cl$ - PCl_3, also V, As, Cb, Sb, Bi. All hydrolysed.

xviii $P/5Cl$ - PCl_5, also Sb, Cb, Ta. All hydrolysed, PCl_5 violently hydrolysed.

xix $V/4Cl$ - VCl_4

xx $2S/2Cl$ /t S_2Cl_2, also Se

xxi $S/2Cl$ /t SCl_2, also Te, Mo, W.

xxii $Mo/3Cl$ /t $MoCl_3$, also Cr, U.

xxiii $S/4Cl$ /t SCl_4, also Mo, W. U

xxiv $Mo/5Cl$ /t $MoCl_5$ also W, U All of this group so far hydrolysed except $MoCl_5$

xxv $Mo/6Cl$ /t $MoCl_6$, stable in water.

xxvi .$Mn/2Cl$ /t $MnCl_2$ (finely divided), also Fe, Co, Ni, Ru, Rh(?), Pd (?), Os, finely divided.

xxvii .$Fe/3Cl$ /t $FeCl_3$, also .Ru, .Rh, Os. All hydrolysed.

xxviii .$Os/4Cl$ /t $OsCl_4$, hydrolysed.

xxix Li/Br /t LiBr, also Na, K, Rb, Cs, .Ag, Tl

xxx Li/I /t LiI, also as for Br

xxxi $Be/2Br$ /t $BeBr_2$, also Mg, Zn, .Cd, Hg (both salts)

xxxii $Be/2I$ /t BeI_2, also as Br

xxxiii $B/3Br$ /t $BBr3$, also whole gorup except Eu, Tb, Dy, Ho, Er, Tm, Yb, Lu, as far as we know

xxxiv $B/3I$ /t BI_3, also Al, Ga, Y, In, La, Ce, Pr, Nd, Sm, Gd_2I_3

xxxv $Si/4Br$ /t $SiBr_4$, also Ti, Zr, Sn, Pb

xxxvi $Ti/4I$ /t TiI_4, also Zr, Sn, Pb Bromides and iodides of all these hydrolyse, and this cannot be due to the affinity for the halogen of the hydrogen of the water as with fluorides and chlorides.

xxxvii $P/3Br/CS_2$ /dt PBr_3/CS_2 —.—.—.—.

(Solution of P in CS_2 unites with Br, at distillation temperature)

Also PI_3, and PI_2

xxxviii $P/5Br$ /dt PBr_5. : : VBr_5 too unstable

xxxix $As/3Br$ /dt $AsBr_3$, or from solution in CS_2. Also AsI_3 and AsI_2. All these hydrolyse.

xl $3AsI_3/4HOH$ /bp $As_2O_3/AsOI/8HI$

xli $Sb/3Br$ /t $SbBr_3$, also SbI_3, or .Sb in solution of Br or I in CS_2

xlii $SbBr_3/HOH$ - $SbOBr/2HBr$, also SbI_3

xliii $SbI_3/2I$ - SbI_5 (?)

xliv $Bi/3Br$ - $BiBr_3$, also BiI_3 Both hydrolyse to BiOBr, BiOI.

xlv $2S/2Br$ - S_2Br_2, also S_2Br_2, also S_2I_2 in CS_2

xlvi Se_2Br_2 and Se_2I_2 in CS_2.

xviii $Te/4Br$ - $TeBr_4$, also TeI_4, $TeBr_3$, TeI_3.

All these sulphur and selenium compounds hydrolyse.

SYNTHESIS OF SULPHIDES.

The synthesis of oxides comes under the heading of COMBUSTION, and has been considered. As sulphur and oxygen are mem-

bers of the same family we have a great number of sulphides corresponding to oxides. Oxygen, however, is a top or "keystone" element, that is akin also to *the next element in its stratum, namely*, fluorine. It is a noteworthy fact that these top elements show more strongly than those below them, constancy of valency, generally low. Complex salts are those of the lower elements in the table. Chlorine in the chlorates cannot well be monad, for the residue from heating would be the hypochlorite, or the oxide of the metal, not the chloride. These lower elements have complex molecular structure, and this would be hardly possible if the element were as say fluorine, which is universally monad. The complexity of these molecules must be overcome by heat, after which in the case of sulphur we have a very active element.

i 2Na/S /wt Na_2S, also Li, K, Rb, Cs, Cu, Ag

ii Na_2S/S /t Na_2S_2, also K_2S, Rb_2S, Cs_2S, Ag_2S, Cu_2S

iii Na_2S_2/S /t Na_2S_3, also K_2S_2, Rb_2S_2, Cs_2S_2, CuS

iv Na_2S_3/S /t Na_2S_4, also K, Rb, Cs, Cu salt

v Na_2S_4/S /t Na_2S_5, also K, Rb, Cs, and Cu salt

All these must be built up away from air, and their solution in water decomposes. Their synthesis might have been shown thus :—

i (vac(2Na/S /wt Na_2S))

v (S(2Na/5S /t Na_2S_5)S) (*in a stream of sulphur*)

vi Mg/S /t MgS, also Ca, Sr, Ba, Zn, Cd, Hg

vii (flux(Mg/S /t MgS)), (under a flux)

viii Ba/3S /t BaS_3

ix Ca/4S /t CaS_4, also Sr, Ba

x Zn/5S /t ZnS_5, also Cd, Mg (?)

xi 2B/3S /t B_2S_3, also Al, Sc, Ga, Y, In, La, Pr, Nd, Sm, Gd, Tl.

All these are hydrolysed in decreasing extent as we descend the table most stability being shown by In and Tl.

xii B_2S_3/2S /t B_2S_5, also In_2S_3, InS, La_2S_3, Tl_2S, CeS_2

xiii C/2S /rt CS_2, also Si, Ti, Ge (?) Zr (?), Sn

Also compounds CS, SiS, TiS, Ti_2S_3, GeS, SnS, PbS

xiv 4P/3S n/- P_4S_3

xv 4N/4S /t N_4S_4, also V_2S_2, As_2S_2

All these are hydrolysed.

xvi 2P/3S /t P_2S_3, also V, As, Sb, Bi

xvii 4P/7S /t P_4S_7

xviii 3P/6S /t P_3S_6

xix 3As/S /t As_3S

xx 2P/5S n/t P_2S_5, also As, V, Sb

xxi 2O/S - O_2S, also Sx

xxii Se/S_2 /t SeS_2, also Te, Mo, W, U.

xxiii Se/S /t SeS, also CrS, US

xxiv 2Cr/3S /t Cr_2S_3, also Mo, U

xxv Te/3S /t TeS_3, also Mo, W

xxvi Mo/4S /t MoS_4

xxvii 6F/S /it F_6S, also I_6S

xxviii 4Cl/S /t Cl_4S

xxix 2Cl/S /t Cl_2S

xxx 2Cl/2S /t Cl_2S_2, also I.

From this series it would seem to show that the sulphur molecule is more complex than the halogens, for it takes varying proportions of them only when opened by heat. They cannot satisfy it individually except where more complicated as with I_2S_2.

xxi Mn/S /t MnS, also Fe, Co, Ni, .Rh, .Pd, Cu.

All hydrolysed by boiling water.

xxxii 2Tl/S /t Tl_2S, also Pd.

Nature has synthesised all her compounds in the earlier stages of her cooling. Iron heated with sulphur forms the sulphide, and this in the presence of warm moist air produces green vitriol $FeSO_4$, which was the source of oil of vitriol, and chemistry itself. Copper, in the same way, produces blue vitriol, $CuSO_4$, which by electrolysis with water produces very pure sulphuric acid. As sulphuric acid is the great acid maker as we shall see later, we have a means of

building a great number of salts by producing the acid first in each case. Sulphuric acid, by its affinity for water, determines an enormous number of reactions in organic chemistry.

SYNTHESIS OF NITRIDES, ETC.

i Li/N /t LiN

ii 3Li/N /t Li_3N

iii 2K/N /t K_2N

iv 3Rb/N /t Rb_3N

v Na/5P /rt NaP_5, also KP_5, Rb_2P_5, K_3P, Cu_6P_2, Cu_3P_2, Ag_2P, Ag_1P_6, Ag_2P_5, Na_3As, K_3As, Cu_6As, Cu_6As_2, Cu_3As_2

vi 3Be/2N /t Be_3N_2, also Mg, Zn, Ca, Sr, Ba. Also Mg_3P_2, Zn, Cd, Hg. Also CaP, Sr_3P_2, BaP, Mg_3As_2, ZnSb

vii B/N /it BN, also Al, In, La, Ce, Pr, Nd, Tl. Also BP, B_5P_3, Al_3P, Al_5P_3, Al_2P, $AlAs_x$, Tl_3P, Tl_3As, Tl_3Sb.

viii .K/.C/N /rt KCN

ix 2K : 2CN/Hg : 2Cl - $Hg(CN)_2$/ 2K : 2Cl

that is solutions of potassium cyanide and *mercuric chloride give a precipitate of mercuric cyanide.*

x $Hg(CN)_2$ /t Hg/2CN

xi Si/N /et SiN (electric furnace). Also Si_2N_3, TiN, Ti_3N_4, Zr_2N_3 Zr_3N_8, Th_3N_4

xii Ti/P /it TiP, also ZrP_2, Sn_3P_2, SnP, Sn_3As_2, Sn_4As_3, SnAs, PbP_2

xiii 3P/5N /t P_3N_5, also PAs, SbP, BiP, Sb_2As, Bi_3As_4.

xiv V/N /it VN, also AsN, SbN, TaN, BiN, VN_2, V_2N, Cb_3N_5

xv (st (3O/2N - N_2O_3) st)

that is in sparks are passed

xvi 5O/2P /t O_5P_2,

also O_5As_2, S_5As_2, Se_5P_2, O_6P_4, O_6As_4, S_3P_2, S_3As_2, Se_3P_2, O_4P_2, W_4P_2, OP_2, SeP_2, OAs_2, S_2As_2, SAs_3, CrP, CrAs, SeP_4, Mo_2P_2, WP_2, U_3P_4, U_3As_4, TeSb

xvii Cr/N /et CrN

also Mo_5N_3, Mo_3N_4, Mo_3N_2, W_2N_3, U_3N_4, Mn_3N_1, Fe_2N, Fe_3N_2, FeN, Co_2N, Co_3N_2, Ni_3N_2

Other nitrides, phosphides, and arsenides of the seventh group may be seen from the tables. These synthesise readily. Those of manganese, etc., require heat.

Nitrides of boron, titanium and vanadium are exceedingly stable. *Carbides and Borides* with *Silicides* are also very hard and stable, and are formed in the electric furnace.

ACID CONSTITUENTS OF LOW TEMPERATURE TARS. THIRD REPORT. CONSTITUENTS OF MONOPHENOL.

By Yoshikiyo Oshima, Yosaburo Kosaka and Shiro Matsumae.

First seven fractions of monophenols, described before, were examined, and carbolic acid, three cresols, and two of xylenols were confirmed.

Carbolic acid was found in a small quantity in each of the first five fractions. It was confirmed by treating them with a dilute solution of ammonia, from which tribromophenal was separated and recrystallised from a *dilute alcoholic solution.* Picric acid was also identified by subjecting the fractions to Raschig's method and recrystallising the products from a dilute alcoholic solution.

The three cresols were separated and identified in each fraction, either by the modified Lederer's method, which had been proposed by the authors in the preceding report, or Raschig's method. The higher phenols which might be present in the fractions could not be examined by these methods.

Three xylenoxy-acetic compounds, *i.e.*, 1 : 2 : 4-, 1 : 3 : 4- and 1 : 4 : 2-isomers, were prepared from respective Kamlbaum xylenols and their melting points and solubilities in various solvents were determined. The results are as follows :

Xylenoxy compounds	M.p.	Solubilities in Benzene	Water	Ligroin	Solubilities of Na-salts in water
1 : 2 : 4	162	0.096	0.066	0.057	5.7
1 : 4 : 2	115.5	3.022	0.268	0.192	20.7
1 : 3 : 4	143	0.420	0.081	0.062	very soluble

A mixture of acetic derivatives of the seventh fraction was prepared and fractionally crystallised from various solvents. The melting points of certain fractions did not depress but elevate when a small quantity of pure cresoxy- or xylenoxy-acetic compound was added to the sample under examination. We made use of these facts and the solubilities described above and confirmed the presence of 1 : 2 : 4 and 1 : 3 : 4 xylenols.

These results show, as reported before, that the original tar acid contains a good many of isomers of higher phenols and it may be difficult to isolate them by usual methods, both chemical and physical.

STUDIES ON SEAWEEDS OF JAPAN. FIRST REPORT. ON THE CHEMICAL CONSTITUENTS OF LAMINARIA.

By Katsumoto Atsuki and Yoshinori Tomoda.

The original paper deals with some experiments on the determination of the several constituents contained in laminaria saccharina.

The chief constituents which have been found by the present authors are as follows :

Mannite	25%
Alginic acid	20
Ash	24
Nitrogenous matter	10
Matters soluble in acid but not in alkali	15
Crude fibre	6
	100

The authors have studied on the oxidation of mannite, obtaining 75 per cent. of sugar by using nitric acid.

The oxidation by chlorine was best carried out by exposing the solution of mannite in chlorine water to the direct sunlight, 56 per cent. of sugar being formed.

The authors have isolated the alginic acid from laminaria and have studied its chemical nature. The alginic acid yields 14.21 per cent. of furfral and 19.89 per cent. of carbon dioxide, when it is treated with hydrochloric acid of sp. gr. 1.060. Its acid value is 262 and the specific rotatory power $[\alpha]^{20} = -130^\circ$. It contains neither galactan unit nor methoxyl group.

In these several respects, the alginic acid very much resembles to pectic acid, and it is supposed that the alginic acid is composed of the galacturonic or glucuronic acid units.

The greater part of the crude fibre of laminaria consists of the hemicelluloses, and the normal cellulose has not been found so far.

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General Notes.

BITUMINOUS SANDS OF CANADA.

Sands which have become saturated with a heavy asphaltic oil or a semi-liquid bitumen are known to underlie an area in excess of 2,000 square miles in Northern Alberta, in the vicinity of Fort McMurray on the Athabaska river. These deposits are usually named the Bituminous sands of Northern Alberta.

This interesting area has been surveyed in great detail by Mr. S. C. Ells, of the Mines Branch, during the past ten years, numerous samples of these saturated sands have been subjected to analysis, and much experimental work has been undertaken to discover commercial uses for the materials present in these beds.

While the deposits themselves are very extensive, the actual area that is readily accessible for commercial operation is probably not more than three square miles. The rest of the deposits lie beneath a heavy burden and will be relatively expensive to operate commercially. The bitumen content of the more valuable portions of the beds varies from 12 to above 15 per cent., with higher percentages in limited areas.

Mr. Ells' report on these deposits, entitled "Bituminous Sands of Northern Alberta" describes the results of his investigations to the end of 1925. Report No. 632. Pp. 244. Department of Mines, Ottawa.

NEW FRENCH MOROCCAN COMPANY LAW.

The *British Consul-General at Rabat* reports that a Dahir of 1 September, 1926, and published in the Bulletin Officiel of 5 October, 1926, renders applicable in the French zone of Morocco the French Law of 7 March, 1925, on "Sociétée à responsabilité limitée." The British Consul-General further reports that the French Law referred to would appear to legalise a kind of cross between a partnership and an ordinary limited liability company. The only important qualification with which it has been made applicable in Morocco is that it is forbidden by the Dahir to give banks and credit establishments the form of a "Société à responsabilité limitée. The Dahir presents one other feature of interest, namely, that it makes it compulsory for companies of the kind contemplated to register in the "*registre du commerce*," and it refers in this connection to a Dahir of the same date (1 September, 1926) making such registration obligatory on merchants and commercial companies generally. The latter Dahir, however, does not appear to have been published in the Bulletin Officiel.

LEEWARD ISLANDS, DOMINICA.

The Revenue for the Presidency for the financial year 1925-26 was £48,623, as compared with £48,153 for 1924-25, expenditure amounting to £58,258, against £55,483. The Public Debt was reduced from £22,057 at the close of the financial year 1924-25 to £19,835 at the end of the financial year 1925-26, during which no loans were either subscribed or sanctioned. The product of limes is the principal industry of the Colony and the short 1925-26 crop adversely affected trade. Cocoa is also cultivated with success and exported in moderate quantities. Coconuts are doing well, especially on the coast.

The total exports in 1925 were valued at £125,596, and consisted principally of limes and lime products and cocoa. Imports for the same year were valued at £146,204, of which £19,795 represented flour, £15,049 cotton piece-goods, £5,431 dried fish, £4,711 bags and sacks, £4,316 butter substitutes, £4,110 oils, edible, £3,627 hardware, and £3,266 boots and shoes. Imports from the United Kingdom were valued at £52,111, those from British North America £32,510, and those from the United States £37,127.

BERMUDA.

The value of the total imports into Bermuda last year was £489,982 less than in 1924, the figures being £1,325,041 and £1,815,023 respectively. The value of exports also declined, from £146,252 in 1924 to 166,020 in 1925. The reduced value of both imports and exports is due principally to the falling off in the re-export trade in alcohocil liquors. but importations of many other articles were on a lower scale. In 1924 no less than 335,900 gallons of whiskey, valued at £316,199, were imported, of which 121,110 gallons, valued at £203,919 ,were exported; but in 1925 the total imports, which were practically all for internal consumption, were valued at only £44,358. The decline in imports for internal consumption in 192 5was probably due to a large carry over from the previous year.

115,000,000 TONS OF SODIUM SULPHATE IN CANADA.

"Sodium sulphate of Western Canada, its occurrence, uses, and technology," is the title of a report under the authorship of L. Heber Cole, *recently issued by the Mines* Branch of the Department of Mines, Ottawa, Canada.

Although the occurrence of saline lakes in Western Canada has been known for many years it was a search for potash during the Great War that directed serious attention to their commercial possibilities and led to their examination in detail. These lakes occur in depressions in the morainic drift of Manitoba, Saskatchewan, Alberta, and British Columbia, they vary greatly in size and salinity from those in which the waters are only slightly alkaline and in which no crystal bed is present to those containing thick bedded crystal deposits, which at certain seasons are completely dry. These deposits consist chiefly of hydrous sodium sulphate (Glauber's salt) with small percentages of magnesium sulphate, sodium chloride, and related salts.

Those investigations by the Mines Branch show the presence in the 21 deposits examined in detail of over one hundred and fifteen million (115,000,000) tons of hydrous salts, mainly sodium sulphate.

In Canada sodium sulphate, in the form of salt cake, finds its largest use in the pulp and paper industry and is also employed in the metallurgical, glass, dye, textile, and other industries. Upwards of 40,000 tons, mostly imported, are used per annum. Until recently most of the salt cake used in commerce has been produced as a by-product in the manufacture of hydrochloric acid from common salt.

PROCEEDINGS AND NOTICES OF SOCIETIES.

ROYAL SOCIETY ANNIVERSARY MEETING.

Sir Ernest Rutherford, the President, occupied the chair at the above meeting held on the afternoon of November 30. In his presidential address he referred to the gratified improvement in international scientific relations.

RADIO PROGRESS.

Among the many developments of science during the past 30 years, none had left a deeper impression on the lay and scientific mind alike than the remarkable growth of wireless as a means of long-distance transmission of signals, speech, music, and even of pictures. The history of this new method of signalling was of special interest to all scientific men, for it illustrated in a vivid way the value of a close co-operation between pure and applied science for rapid progress. The first great chapter in the history of radio-communication they owed to the genius of Maxwell, who communicated a paper to that society in 1864 entitled "A Dynamical Theory of the Electromagnetic Field." Having pointed to the researches of Hertz and the pioneer work of Marconi and Lodge, Sir Ernest said that progress in the later stages had been largely influenced by the utilization of another scientific discovery—namely, the use of electric currents in vacuum tubes as a powerful method of producing and detecting electrical waves. It was of interest to note that the first use of an electron tube as a detector of electrical waves was made by Professor J. A. Fleming.

With reference to the noteworthy developments that had taken place this year, he said that, on January 1, the new Post Office station at Rugby was opened for the transmission of messages to ships in all quarters of the globe and for Foreign Office messages. This long wave installation was in many respects unique. It was the only high-power electron-tube station in the world and contained many novel features in its design and operation. The frequency of the continuous waves emitted by this station was controlled with great accuracy by a vibrating tuning fork, and the numerous high-power electron tubes in parallel were used to magnify 500,000 million times the energy of one of the harmonics of a small triode valve operating the tuning fork. Te extraordinary flexibility of these electron tubes, both as oscillators and receivers, had been fully utilised in the design of the installation, which incorporated all the latest developments in this branch of science. The success of the station for the purposes for which it was designed was a tribute to the breadth of the scientific knowledge and the boldness of the initiative displayed by the Imperial Wireless Commission and the engineering staff of the Post Office. This station had been also successfully used for experiments in radio-telephony with the Long Island station near New York. It was now possible, and would, it was expected soon be practicable, to connect any telephone subscriber in Western Europe with any telephone subscriber on the North American continent.

The following are the names of the Officers for the coming year :—

President, Sir Ernest Rutherford; *treasurer*, Sir David Prain; *secretaries*, Mr. J. H. Jeans and Dr. H. H. Dale; *foreign secretary*, Sir R. T. Glazebrook. Other *Members of the Council*: Sir H. K. Anderson, Dr. F. W. Aston, Professor Leonard Bairstow, Professor F .O. Bower, Sir A. E. Garrod, Professor E. J. Garwood, Sir T. L. Heath, Professor J. P. Hill, Dr. P. Chalmers Mitchell, Professor R. Muir, Sir J. H. Parsons, Sir R. Robertson, Mr. A. A. C. Swinton, Sir G. T. Walker, Sir James Walker, and Mr. W. C. D. Whetham.

ANNIVERSARY DINNER.

The 264th anniversary dinner of the Royal Society was held on the evening of November 30, at the Hotel Cécil, Sir Ernest Rutherford presiding.

THE ROYAL SOCIETY.

The following papers were read on Thursday, December 2nd, 1926, at 4.30 p.m. :—

Optical Rotatory Dispersion. Part III. The Rotatory Dispersion of Quartz in the Infra-Red, Visible and Ultra-Violet Regions. By T. M. LOWRY, F.R.S., AND W. R. C. COODE-ADAMS.

Measurements of optical rotatory power of quartz were begun in 1908 with a view to testing, in the most drastic way possible, methods that were being developed for studying rotatory dispersion in organic pounds.

Data are now given for the rotatory power at 20° C. of a column of quartz, 496.4735 mm. in length, over a range of wave-lengths from 25,170 to 2263 A.U. Observed rotations range from 450° to 101,332°, and rotations per mm. from 0.906 to 202.328°/mm. The latter can be expressed, over the entire range of wave-lengths, by the formula—

$$\rho = \frac{9.5639}{\lambda^2 - 0.0127943} - \frac{2.3113}{\lambda^2 - 0.000974} - 0.1905$$

The average error for 23 lines in the visual region has been reduced to 0.0007°/mm., as compared with 0.0015°/mm. in the table published in 1912, mainly as result of using more accurate values for wave-lengths. In the photographic region average systematic error for a series of 805 lines, mainly derived from the iron-arc, was only −0.0001°/mm., whilst average casual error was $\pm$0.0046/mm.

In the infra-red, where the positions on a scale of wave-lengths of maxima and minima of transmission for a given position of polariser and analyser were determined by thermopile and galvanometer, casual errors amounted to $\pm$ 0.012°/mm., whilst average systematic error was −0.0005°/mm.

The formula above, which appears to fit the data within limits of error of observation, postulates the existence of bands of selectice absorption at 1130 and 310 A.U. The influence of infra-red bands is covered by the small constant − 0.1905.

Structure in the Secondary Hydrogen Spectrum. V. By O. W. RICHARDSON, F.R.S.

In this paper it is shown that Fulcher's red bands as extended by various authors form a sequence of bands with the respective vibration transitions 0 ⟶ 1, 1 ⟶ 1, 2 ⟶ 2, 3 ⟶ 3, 4 ⟶ 4 and 5 ⟶ 5. The green bands belong to the same group and have the vibration transitions 1 ⟶ 0, 2 ⟶ 1, 3 ⟶ 2, 4 ⟶ 3, and 5 ⟶ 4. Associated with these are five bands in the infra-red transitions 0 ⟶ 1, 1 ⟶ 2, 2 ⟶ 3, 3 ⟶ 4, and 4 ⟶ 5 and four in the blue-green with transitions 2 ⟶ 0, 3 ⟶ 1, 4 ⟶ 2 and 5 ⟶ 3. The blue bands arranged by Dieke form a sequence in another group and have the transitions 0 ⟶ 0, 1 ⟶ 1, 2 ⟶ 3, 3 ⟶ 3 and 4 ⟶ 4. Belonging to this group are three other sequences with transitions 1 up, 1 down, and 2 down respectively. There are also at least three less well-developed groups in the violet side of these.

The Q (1) lines of the bands with 0 ⟶ 0 vibration transitions are given by the Rydberg-Ritz formula

$$\nu = A - \frac{R}{(m - 0.056704 - 0.06080/m^2)^2}$$

where A = 29330.305, R = 109678.3 and m = 3, 4, 5, 6, 7, 8.

The value of A is close to that of the second member when m = 2. It follows that the various groups of bands are associated with electron transitions 3 ⟶ 2, 4 ⟶ 2, 5 ⟶ 2, etc. The lines of the Q branches are tabulated and are shown to be connected together by a combination rule which extends not only within each group but also from each group to the others. The arivous electronic vibrational and rotational terms are analysed and their connection with the moments of inertia, ionisation and radiation potentials and heats of dissociation of the various molecules and with the band spectrum in the Lyman region is discussed.

THE CHEMICAL SOCIETY.

December 2, 1926.

Dicyanates and Dibenzoates of Triphenylbismuthine and Triphenylstibine. By F. CHALLENGER AND V. K. WILSON.

Triphenylbismuthine dicyanate, like the dichloride, is stable at ordinary temperature, whereas triphenylbismuthine dithiocyanate and diselenocyanate immediately revert to derivatives of tervalent bismuth, yielding phenyl thiocyanate and selenocyanate. Comparative experiments indicate that the dithiocyanate is slightly more stable than the di-iodide, hence iodine is, apparently, more positive than thiocyanogen.

With benzoyl peroxide, triphenyl-bismuthine and -stibine yield the corresponding dibenzoates $Ph_3M(OCO\ Ph)_2$, whilst tri-

phenlphosphine gives benzoic anhydride and triphenylphosphine oxide.

The Mechanism of Citric and Oxalic Acid formation from Sugar by Aspergillus Niger. Part I. By F. CHALLENGER, V. SUBRAMANIAM AND T. K. WALKER.

When the sugar in Molliard's culture medium is replaced by citric acid the mould produces (*a*) malonic acid, (*b*) acetone, and (*c*) glyoxylic acid; (*a*) was detected as hydrogen formazyl and as cinnamylidene-malonic acid, and was isolated by way of the lead salt. Acetone was detected by the idoform reaction, and by the formation of distyryl ketone and acetone *p*-nitrophenylhydrazone. Glyoxylic acid, detected by the naphtharesorcinol colour test and by its aminoguanidine derivative is also produced when the mould is grown on malonic or acetic acid as sole source of carbon, being accompanied in the latter case by glycollic acid.

When the mould is grown on dipotassium saccharate, the solution is free from acetone, but gives reactions indicating the presence of citric acid.

Muconic and Hydromuconic Acids. Part IV. Geometrical Form and Reducibility. By E. H. FARMER AND W. M. DUFFIN.

Owing to the comparative stability of gometrical isomerides in the muconic acid series, it is possible to compare the reactivity of the different forms. Some twelve compounds of the series have been examined with regard to their comparative reducibility and the nature of the reduction product.

In the monohalogenated muconic esters, variation in reducibility is distinct and appears to be governed by purely steric factors. In other series it is less marked. With simple muconic derivatives the dihydrogenated product is exclusively of one geometrical form. This is probably due to the very low degree of stability of the second (presumably *cis*) form, which has resisted all efforts towards synthesis. In the $\beta\beta'$-diphenylmuconic acid series, the form of the dihydrogenated product depends on that of the muconic derivative reduced.

The Effect of Gem-*Dialkyl Substituents on the Formation and Stability of the Anhydrides of Dicarboxylic Acids.* By E. H. FARMER AND J. KRACOVSKI.

The anhydride-formation of various acids of the adipic series has been examined. In each of these cases the anhydride is derived from one molecule of the acd, and differs from anhydrides of the succinic and glutaric series mainly in stability (ease of hydrolysis and resistance to heat).

The effect of *gem*-dialkyl substituents is shown plainly in the series adipic acid, β-methyladipic acid, $\beta\beta\beta'\beta'$-tetramethyladipic acid, $\alpha\alpha\alpha'\alpha'$-tetramethyladipic acid. The nature of this effect in relation to the current theories is discussed. In this connection, attempts to bring about ring closure of $\alpha\alpha\alpha'\alpha'$-tetramethyladipic acid by bromination, followed by potash treatment have been unsuccessful.

Photochemical Equilibrium in Nitrogen Peroxide. By R. G. W. NORRISH.

When nitrogen peroxide is illuminated by rays from the mercury-vapour lamp, a slow increase in pressure is obtained which is too great to be ascribed to the heating effect of the light. After screening from the light, the return to normal pressure is at first rapid and then slow. By adding excess of nitrate oxide or oxygen the pressure change is very largely suppressed; it is mainly due to the establishment of a photochemical equilibrium: $2NO_2 \rightleftharpoons 2NO + O_2$.

The photochemical reaction is bimolecular, probably taking place on the collision between a photo-active and an inactive molecule of nitrogen peroxide. Oxygen atoms are not produced in the reaction, as no water is formed in the presence of hydrogen.

The photochemically active light lies between the limits 43600 and 3650 A., all the lines of the mercury vapour lamp within this region being strongly absorbed and probably photochemically active. Maximum and minimum estimates of the quantum efficiency are 0.03 and 0.01, indicating that the energy level of photochemical activation is not of itself sufficient to cause decomposition, and that a further quantity of energy in addition must be obtained from favourable collisions between active and inactive nitrogen peroxide. It is proposed later to determine the effect of temperature on the reaction.

THE OPTICAL SOCIETY.

At a meeting of the Optical Socicty held at the Imperial College of Science and Technology, South Kensington, on Thursday, 11 November, 1926, the following papers were presented and discussed.

The Effect of Slightly Selective Absorption in the Paint used for Photometric Integrators. By J. W. T. WALSH, M.A., M.Sc., AND W. BARNETT.

A sensibly non-selective internal coating for photometric integrators is very difficult to produce and still more difficult to maintain. It is clear that when lamps of different colour temperatures are compared in an integrator with an internal coating which shows selective absorption in, say, blue, the values of candlepower obtained for the lamps of lower colour temperature will be too high and *vice versa*. The existence of this effect has long been known, but its magnitude has not hitherto been determined to any degree of accuracy. The paper describes a theoretical treatment of the problem, and gives a simple method for calculating the magnitude of the effect in the case of sources having a spectrum approximating to that of a black body. The method has been tested by actual photometric measurement and a satisfactory agreement between theory and practice has been found. It is shown that in work on normal type electric lamps to an accuracy of 1 to 2 per cent. a quite noticeable coloration of the light may be produced by the sphere (either on account of paint or window selectivity or both)without the necessity for making any correction to the measured values of candlepower.

An Accurate Method of Ascertaining the Position of the Focal Point of an Optical System. By CONRAD BECK, C.B.E.

A simple and accurate method of finding the positions of the foci of different zones of microscope object glasses is described. It consists essentially in placing a diaphragm with two slit apertures behind the object glass to be tested, the directions of the slits being at right angles to one another, and finding the position where the images form a symmetrical cross. Results of measurements be this method of the zonal abberations of apochromatic object glasses are given.

SOCIETY OF PUBLIC ANALYSTS.

The following papers were read at the meeting held at the Chemical Society's Rooms, Burlington House, London, on November 3, 1926 :—

Investigations into the Analytical Chemistry of Tantalum, Niobium and their Mineral Associations. VI. The Precipitation of the Earth Acids by Sodium Compounds. By W. R. SCHOELLER, Ph.D., AND C. JAHN.

When tantalic oxide is fused with potassium carbonate and the solution of the mass treated with sodium chloride, 4 : 3 sodium tantalate is precipitated. Niobic oxide treated in the same manner yields 7 : 6 sodium niobate. The precipitates are dense, crystalline powders. The filtrates contain a few milligrammes of non-precipitated earth acid, substantial recovery of which is effected by partial neutralisation to the bicarbonate stage and digestion on the water-bath; hydrolytic dissociation in alkaline solution takes place, and the earth acid is precipitated. Sodium tantalate and niobate are decomposed by dilute acid; the quantity of the latter is proportional to that of the alkali in the precipitates. This reaction was applied to the indirect volumetric determination of the earth acids in the mixed sodium salts, but the results were rather wide as the end-point could not be ascertained with sufficient sharpness by the use of colour indicators. The analytical applications of the precipitates are under investigation.

A Simple Method of Testing for Sulphites in Foods. By A. E. PARKES, F.I.C.

The food (if not a liquid) is mixed with water and placed, together with fragments of marble and dilute (about 2*N*) hydrochloric acid, in a conical flask, closed with a rubber stopper bearing a small thistle funnel bent twice and having a small bulb on each limb. The funnel contains a few drops of dilute (0.01*N*) iodine solution and dilute barium chloride solution. After evolution of carbon dioxide has ceased, the flask is heated, and, in presence of a sulphite the colour of the iodine in the funnel is discharged, and the liquid becomes opalescent (barium sulphate). The test may be made approximately quantitative.

A Critical Review of the Methods of Analysing Waters, Sewages and Effluents, with Suggestions for their Improvement. By J. W. HAIGH JOHNSON, M.Sc., F.I.C.

The present methods are shown to yield results which are often unreliable and inconsistent. Recent modifications in sewage treatment have greatly increased the amount of nitrogen oxidation products in sewage treatment and have thus increased the difficulties. A comparison of the results given by the Wanklyn, Kjeldahl, acid chemical, and biological processes has indicated that, in its present form, the first is too

vague, whilst the acid chemical test yields only a fifth of the result obtained biologically. A method of combining the Wanklyn test and the alkaline oxidation method is described and suggestions are made for improving the Kjeldahl test and the biological determination of absorbed oxygen.

SOCIETY OF GLASS TECHNOLOGY.

The Society of Glass Technology was inaugurated at a meeting held in the University of Sheffield, on November 9, 1916. The November 1926 meeting, therefore, marked the Tenth Anniversary of the Society's activities, and special functions were arranged to celebrate the occasion.

On the evening of Tuesday, November 16, an informal dinner was held at the King's Head Hotel, Sheffield. The President, Mr. W. Butterworth, Senr., M.A., was in the chair. The guests of the evening were Sir W. H. Hadow, C.B.E., D.Mus., LL.D., and Mr. W. M. Gibbons, O.B.E., M.A., Vice-Chancellor and Registrar, respectively, of the University of Sheffield.

On the morning of November 17, a visit was paid to the glass works of the British-Thomson-Houston Co., Ltd., at Chesterfield. A large party of members was welcomed by the manager, Mr. A. E. Hill, B.Sc. The party returned to Sheffield for luncheon, prior to the general meeting which was held in the afternoon.

At this meeting Col S. C. Halse was in the chair, and Mr. Walter Butterworth, Senr., M.A., delivered his Presidential Address, his subject being "A Ten Years' Retrospect." The Society, he said, had emerged out of the ferment and difficulties of the Great War. The University of Sheffield, in its admirable undertaking to establish a Department of Glass Technology, acted finely and rendered unique and pioneer service to the country in the nick of time. From its activities sprang the Society of Glass Technology. The Department and the Society had co-operated, with valuable results primarily to the scientific world, and notably also in organising and assisting the whole body of glass manufacturers at home, without any shadow of exclusion of fellow-workers abroad. The Society, through its *Journal*, soon became the organ of the glass industry on its scientific side. It was now recognised internationally as having taken a high place among scientific societies. The Society, almost wholly British at the start, soon gained recognition abroad, especially in the United States, and its membership now included firms and individuals in a score of countries. From the beginning, members had included not only manufacturers, merchants, dealers, workers and students in the glass industry, but also those concerned in the production of raw materials, refractory materials, furnaces, machines, tools and all accessories for the glass trade. Professor W. E. S. Turner had been and remained its energising spirit, and he had had splendid help from colleagues of the University of Sheffield, from the staff of the Department of Glass Technology and from distinguished members of the staffs of great glass and other firms in the country. The record of their work was open to all in the ten goodly volumes of the Society's *Journal*. It was important to the Department and to the Industry that there should be a regular succession of students passing through the Department, to be trained theoretically and practically for posts in the glass factories of the land.

The meetings and conferences arranged by the Society soon bore fruit. Gradually it was recognised that in place of jealous privacy they needed mutual help, co-operation, comparison of experiences and discussion of difficulties. Here the Society introduced a healthy stimulus, for it was chiefly responsible for bringing manufacturers into frequent and friendly contact. It tabled practical problems for discussion. It induced manufacturers to visit each other's works. It arranged tours abroad and visits to glass works in the United States, France and Belgium. It invited fellow-manufacturers in those countries to pay return visits to their English works and to join in friendly conference. In their ancient and interesting trade there were many problems to face, and by combined effort they could surmount them better and more swiftly than by mutual suspicion or dogged conservatism.

There were ways other than political of directing attention to their national glass industry. It had enjoyed less than its fair share of publicity. To remedy this defect the Society had recently mooted a project to associate with a great convention in London the organisation of a fully representative glass exhibition. Another proposal shortly to be considered by the Society was to bring closer together, and to collaborate in some form with, other bodies interested in particular aspects of glass. As a Society of Glass Technology they had

devoted themselves mainly and fundamentally to applying scientifi cmethods and research to the problems of glass manufacture. Now and again, the artistry of glass had received attention. Colour, form, design, decoration in glass might be fascinating, and they constituted much of the attractiveness which glass had for many sections of the public. It was felt that nothing in glass should be regarded as alien to the Society, and they might well consider whether they should aim at including both science and art in their activities.

GEOLOGICAL SOCIETY OF LONDON.

At the meeting on November 17, 1926, Dr. F. A. Bather, M.A., F.R.S., President, in the chair, the following paper was read:

The Shineton Shales of the Wrekin District with Notes on their Development in other parts of Shropshire and Herefordshire. By CYRIL JAMES STUBBLEFIELD, Ph.D., D.I.C., F.G.S., AND OLIVER MEREDITH BOONE BULMAN, Ph.D., D.I.C., F.G.S.

In the Wrekin district, the Shineton Shales have been found to represent almost the whole of the Tremadocian succession, as developed in the Tremadoc district. The following subdivision of the shales in this main outcrop was outlined in an earlier publication, and is here more fully discussed:—

(6) Arenaceous Beds.
(5) Zone of *Shumardia pusilla.*
(4) Brachiopod-Beds.
(3) Zone of *Clonograptus tenellus.*
(2) Transition-Beds.
(1) Zone of *Dictyonema flabelliforme.*

In the smaller outcrops of the shales lying on the west and south-west, only the lower part of the sequence has been identified; thus, in the Stiperstones district the presence of the *D.-flabelliforme and C.-tenellus* Zones is suggested, while in the Lawley, Cardington, and Pedwardin areas the *D.-flabelliforme* Zone alone is recognised.

A table is given comparing the succession in Shropshire with that of other Tremadocian areas, and showing notably the wide distribution of *D.-flabelliforme* and of the *Shumardia-pusilla* fauna. Close comparison may be drawn with the sequence seen in the St. Tudwal's Peninsula of North Wales, although there the uppermost beds are not yet recognised; with the Swedish development, however, comparison is more complete.

In the Wrekin district a thick mass of shales has been compressed against a north-eastern ridge formed of earlier Cambrian and pre-Cambrian strata, resulting in isoclinal folding with faulting in the north-eastern part of the shale outcrop. In the south-west of the district the shales are less disturbed, except in the immediate neighbourhood of the Church Stretton Fault.

Six new species of trilobites have been established, of which three belong to new genera; descriptions are also given of one new brachipod and three new Hyolithids.

NOTICES OF BOOKS.

Die Verwendung der Rontgenstrahlen in Chemie und Technik. By HERMANN MARK. Pp. XVI + 528. Leipzig: Johann Ambrosius Barth. 1926. Price, unbound, 48 marks, bound, 50 marks.

This important book of outstanding merit has been written especially for chemists, physicists and engineers for whom the information has been gathered from all sources. It deals with the principles of X-rays, the types of apparatus used to produce them, how to apply them and what they can do.

The book is divided into five sections. The first deals with the production of Rontgen- or X-rays, their nature and characteristics and how they arise. Modern technique in regard to the obtaining of high vacua is very fully discussed together with descriptions of different types of X-ray tubes. Section II. deals with X ray analysis and spectroscopy, giving an account of the results achieved by the applications of X-rays. Phenomena associated with absorption, scattering and polarisation are then considered in all their aspects, the characteristic lines of the elements, as far as has been determined, are shown in extensive tables. At the end of this section attention is directed to the importance of X-ray spectroscopy as an aid to chemical analysis.

Setcion III. begins with the recent work on crystal structure, this part perhaps being the most familiar to English readers through the work of Sir William and Prof. Bragg. The lengthy succeeding section is chiefly devoted to technique. The work is profusely illustrated throughout with many plates, diagrams, and in addition there are numerous tables of great value for reference, particularly to those engaged upon in-

vestigations in this subject. There is a full list of references in section five, which, like the rest of this compendious volume has been compiled with great labour.

The claims of Noddacks and Berg to the discovery of eka- and dvimanganese seems to be recognised in their own country, for we note in Dr. Mark's table of the elements and in the text these are referred to as masurium and rhenium.

It has taken the reviewer over twenty hours to peruse this book, in the course of which he has learned much. There has also been much that he has not understood, especially in the mathematical treatment. The German is, however, in an easy style, but the reviewer is in no position to criticise the author's masterly presentation of the subject.

J. G. F. D.

Materie, Elektrizität Energie. By W. GERLACH. Second enlarged edition. Pp. XII. + 292. Dresden and Leipzig: Verlag von Theodor Steinkopff. 1926. Price, unbound, 15 marks; bound, 16 marks 50 pf.

It is only three years ago since the *Chemical News* reviewed (1923, CXXVII., 159, September 7), the first edition of Professor Gerlach's important work on recent theoretical and experimental work on atomic and sub-atomic phenomena and it is an indication of the trend of scientific interest that a second edition of this book, which is Volume VII. of a series of monographs on scientific research edited by Professor Liesegang, has been called for.

The author has availed himself of the opportunity to add much new matter especially relating to theoretical physics and the book has indeed almost doubled in size.

Professor Gerlach gives a survey of the investigations dealing with the nature of the electron and the atom. It is interesting to note how recent advances have chiefly resulted from the labours of physicists. The early progress made by chemists during the beginning and end of last century was essentially the result of " bulk " studies and was more statistical than minutely exact. The latest refinements in apparatus and measurement have enabled the physicists to make their valuable contributions to the knowledge of the structure of matter.

This book is addressed primarily to those working in this restricted branch of science, but will doubtless be read with interest by many who are not specialists.

J. G. F. D.

A Text Book of Inorganic Chemistry. Edited by J. NEWTON FRIEND, D.Sc., Ph.D., F.I.C. (Carnegie Gold Medallist). Vol. III., Part II.—Beryllium and its Congeners. By JOSHUA C. GREGORY, B.Sc. (Lond.), F.I.C., AND MAY SYBIL BURR (née Leslie), D.Sc. (Leeds). Pp. XXVI. + 342. Price 18s. London: Charles Griffin and Company, Ltd., 41, Drury Lane, W.C.2.

While a high mede of praise is due to the General Editor of the useful series of books under the above title, he has been well supported by the particular editors and by the publishers, and also the printers. The result is that the books possess high intrinsic value by reason of the nature and arrangement of the contents, and are handsome in appearance. Useful and ornamental are applicable to them.

In the present books (Part II. of Vol. III.), Beryllium and its Congeners—Magnesium, Zinc, Cadmium, Mercury, all of which elements occupy an important place in chemistry, are fully discussed. The editors explain that no effort has been spared to secure accuracy, supported by authority where necessary. The name index and also the subject index are exhaustive, which considerably enhances the value of a book of this kind.

Indicators, Their Uses in Quantitative Analysis and in the Colorimetric Determination of Hydrogen-ion Concentration. By DR. I. M. KOLTHOFF, State University, Utrecht. An authorised translation by N. HOWELL FURMAN, Ph.D., University of Princeton, N. J., U.S.A. Pp. XII. + 270. Price 17s. 6d. net. New York: Wiley & Sons, Inc., and London: Chapman & Hall, Ltd., Henrietta Street, Covent Garden.

The books of Dr. Kolthoff are too well known to need general commendation, and the book of which the present is an authorised translation is unquestionably one of the most important productions of his pen. This was demonstrated by the fact that the first edition soon became exhausted, which called for a second issue, and which, in the main, followed the arrangement of its predecessor. Owing to the varying qualities of a dye that may be used as an indicator and which experience frequently shows is put on the market in different degrees of purity, the author deemed it advisable " to give descriptions of the indicators to serve as criteria." The second edition contains some additions and new papers which were not found in the first edition. The first and second editions were published in 1921 and 1923 respectively. The Book before us is

something more than a translation, inasmuch as it has a new chapter, the principal material for which was supplied by Dr. Kolthoff, who also provided numerous additions which will be found in different parts of the book. The translator has also added author and subject indices, which will be found an improvement,

FORTHCOMING EVENTS.

ROYAL SOCIETY OF ARTS.

Friday, December 10, at 4.30 p.m.—Cecil Henry Bompas, C.S.I., " The Work of the Calcutta Improvement Trust."

Wednesday, December 15, at 8.30 p.m.—Professor William J. Woolcock, C.B.E., General Manager, Association of British Chemical Manufacturers, " Some Aspects of the Chemical Industry."

SOCIETY OF GLASS TECHNOLOGY.

Wednesday, December 15, at 2.30 p.m.—General meeting, at University College, Gower Street, London W.C.1. Papers to be read :—

(a) " Some Corrosion and Erosion Phenomena and their Bearing on the Macro structure of Refractories." By J. F. Hyslop, B.Sc., R. Gumm, and H. Biggs.

(b) " A Note ou the X-ray Patterns of Mullite and Sillimanite." By. J. F. Hyslop, B.Sc., and H. P. Rooksby.

(c) " Further Note on Sillimanite as a Glass Works Refractory." By Professor W. E. S. Turner, D.Sc.

(d) " The Viscous Properties of Glass." By Vaughan H. Stott, M.Sc.

(e) " The Effect of Cullet on the Melting of Glass." By Professor W. E. S. Turner, D.Sc.

(f) " The Design of Parison Moulds." By S. English, D.Sc.

Papers (a) and (b) are communications from the Research Laboratories of the General Electric Co., Ltd.

Paper (d) is a communication from the National Physical Lahoratory.

THE PHYSICAL SOCIETY.

At 5 p.m. on Friday, December 10, 1926, at the Imperial College of Science, Imperial Institute Road, South Kensington, S.W.7., the following papers will be read :—

" The Principle Governing the Distribution of Current in a System of Linear Conductors," by Frank Wenner, Ph.D., Physicist, Bureau of Standards, Washington.

" A Capacitance Bridge of Wide Range, and a New Inductometer," by Albert Campbell, M.A.

A demonstration of " The Behaviour of Bodies with Non-Conducting Surfaces in Electrostatic Fields " will be given by Mr. L. G. Vedy.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

29,048.—I. G. Farbenindustrie Akt.-Ges. —Condensation products, etc., of the benzanthrone series. November 17th.

29,163.—I. G .Farbenindustrie Akt.-Ges. —Manufacture of cyclohexylamines. November 18th.

29,275.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of azo-dyestuffs. November 19th.

29,276.—I. G. Farbenindustrie Akt.-Ges. —Manufacture of pyrazolone-azo dyestuffs. November 19th.

29,262.—Trautmann, J.—Vessels for carrying out chemical, etc. processes. November 19th.

Specifications Published.

250,892.—Sharp and Dohne.—Production of alkyl resorcinols.

261,133.—Cassells & Co., Ges., J.—Process for the production of arsinic acids of the aromatic series.

261,240.—British Dyestuffs Corporation, Ltd., and Coffey, S.—Manufacture of acylhalides.

Abstract Published.

259,166.—Phosphatides.—Bollmann, H., 1, Alsterdamm, Hamburg, Germany.

Phosphatides recovered from vegetable substances are purified by distillation under reduced pressure after the main mass of oil has been separated by centrifuging. The water, accompanied by the bitter principles and other constituents influencing the taste distil over and little decomposition of the phosphatides takes place. Should the amount of water in the mixture be insufficient for complete distillation, water may be

added before the distillation, or steam blown in during the distillation. In an example, phosphatides recovered from soya beans together with their accompanying impurities, including water, are heated in a vacuum apparatus to 60° C. The bitter principles, free fatty acids, and other substances distil over with the steam. The product remaining may be employed in this form in the manufacture of margarine. If into their classes, they are heated in concentrated alcohol and the insoluble phosphatides filtered off. If the solution is cooled the slightly soluble phosphatides crystallise out and the solution remaining on evaporation gives pure lecithin.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

ERIOPLYNON.

473,707.—Chemical substances in Class 1.—J. R. Geigy Société Anonyme, 51 and 57, Riehenring, Basle, Switzerland. November 24th, 1926.

INVICTA.

473,725.—Chemical substances used in manufactures, but not including paints, enamels and varnishes, and not including any goods of a like kind to any of these excluded goods.—Thomas Hill Jones, Ltd., Invicta Works, Bow Common Lane, London, E.3. November 24th, 1926.

OMO.

473,474.—Chemical substances prepared for use in medicine and pharmacy, but not including ointments or soap and not including any goods of a like kind to any of these excluded goods.—Joseph Nathan & Co., Ltd., 16, St. Helen's Place, London, E.C.3. 24th November, 1926.
E.C.4. December 10, 1926.

LUNICOT.

469,661.—Chemical substances prepared for use in medicine and pharmacy.—H. R. Napp, Ltd., 3 & 4, Clements Inn, Kingsway, London, W.C.2. 24th November, 1926.

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THE CHEMISTRY OF LIGNIN.

By C. DOREE, M.A. (Oxon.), D.Sc., (Lond.), F.I.C.

Lignin, next to cellulose, is the most characteristic and most abundant constituent of woody tissues. It is obviously of vital importance in plant life, but of its origin, its relation to the other constituents of the plant cells, and even of its chemical nature, practically nothing is known. It is probably because of this lack of knowledge that lignin constitutes one of the most massive waste products of modern industry.

A study of the admirable monograph by Dr. Fuchs*, of the Deutsche Technische Hochschule in Brünn, himself a leading worker in this field, emphasises this lack of information. At the same time it supplies a sound basis for future advances owing to the completeness and skill with which all existing facts have been brought together and critically discussed.

The work is divided into twelve main sections, with sub-divisions, and includes 86 tables embodying the numerous results scattered through the literature. The first sections, treating of the chemistry of lignin, show clearly that, in dealing with this substance, as with most colloidal products of living tissue, difficulties are encountered on every hand. According to the method of isolation different lignins are obtained and the question: " Is there one lignin, or many?" remains unanswered. Again, various reactions produce minute quantities of aromatic substances of the type of vanillic acid, pointing, possibly, to the presence of the 1 : 3 : 4 substituted benzene ring in the complex, yet on oxidation no intermediate products based upon benzene have ever been obtained in quantity, and a glance at the chapter headed " Constitution," shows that there is no satisfactory evidence for any of the formulæ that have been ascribed to lignin.

Later sections of the book are devoted to the question of the relation between lignin and cellulose in woody tissue. Are they combined together and if so, what is the nature of the union, acetal, ether or glucosidal? Or are they in a state of colloidal penetration as postulated by Wislicenius? The treatment of all these problems is excellent and the author's careful marshalling of his facts and the critical faculty he displays in discussing them make these sections most useful and most readable. The high standard is maintained in subsequent chapters in which

are considered the origin and distribution of lignin in the plant world, together with the changes taking place in the lignified cells of the plant during growth, in disease and after death. The breadth of treatment may be illustrated by reference to the inclusions of the serum diagnosis methods of Mez (p. 204) and the originality of the author by the deductions he makes from the discovery of the "crystallite" structure of vegetable fibres. He is very sound in arguing that in dealing with these colloidal structures we must get away from the atom and molecule of the crystal and go back to the proton and the micelle.

The work deals with a difficult borderline subject, comprehensively and critically. It should prove equally useful to the chemist, the botanist and the biochemist. It is a monograph of a high order and may be commended to workers in all these fields.

**Die Chemie des Lignins.* By Dr. Walter Fuchs. Pp. IX. + 327. Berlin: Julius Springer. 1926. Price, paper, 18 r.m.; bound, 19.50 r.m.

FERRIC AND MANGANESE DICHROMATES.

By S. Husain and J. R. Partington.

Attempts to prepare iron chromate from alkali chromates and ferric salts gave indefinite mixtures (Thomson, *Phil. Trans.*, 1827, 218; Eliot and Storer, *Proc. Amer. Acad. Arts Sci.*, 1861, V., 216; Hensgen, *Ber.*, 1879, XII., 1300, 1656; Maus *Pogg. Ann.* 1827, IX., 132), by the action of chromic acid solution on ferric hydroxide obtained a solution which, by a method of analysis of questionable accuracy, gave Fe_2O_3 25.06; CrO_3 74.94, which was supposed to correspond with Fe_2O_3, $2CrO_3$. Eliot and Storer (*op. cit.*, 211), point out an error of calculation in Maus's work; his figures really give more than four equivalents of CrO_3 to one of Fe_2O_3, and they consider that his substance was "an unquestionably indeterminate mixture." Dumas (*Traité de chimie appliq.*, Liège, 1848, Vol. VII, 319), states that Maus's results "are contested by Berzelius." Calcagni (*Gazz.*, 1925 LV., 401), whose paper appeared in the course of our work, states that the substance dried at 140° has the formula

$$\begin{matrix} Fe = Cr_2O_7 \\ >O \\ Fe = Cr_2O_7 \end{matrix}$$

We find, however, that the substance is decomposed at that temperature, losing most of its chromate oxygen.

Parravano and Pasto (*Gazz.*, 1907, XXXVII., 252) and Briggs (*Z. anorg. Chem.*, 1908, LVI., 246) describe a dichromate of manganese with four molecules of pyridine of crystallisation. Gröger (*Z. anorg. Chem.*, 1910, LXVI., 17), obtained from aqueous solution a decomposed product only.

Experimental.

Ferric Dichromate. Pure chromic anhydride, prepared by the action of sulphuric acid on potassium dichromate (Traube, *Ann.*, 1848, LXVI., 165) followed by grinding with concentrated nitric acid, draining and heating at 80° in a current of dry air (Bunsen, *Ann.*, 1868, CXLVIII., 290), was dissolved in water and treated with excess of freshly precipitated ferric hydroxide for several days at 80-90°. The cool solution was filtered through paper or asbestos, and the filtrates evaporated at 90° ,and finally dried in vacuum over phosphoric oxide. The products were identical, which seems to indicate that no free chromic acid was present in the solution. Analysis of the solids (Treadwell and Hall, Vol. II., 1919, p. 113) gave in all cases a ratio Fe_2O_3 :CrO_3 of very nearly 1 to 6.0 (*e.g.*, 6.04, 6.03, 5.98). This was unchanged when the solid was heated with water and more ferric hydroxide at 90° and the filtrate evaporated as before. The results indicate that the product is a definite compound Fe_2O_3, $6CrO_3$, or $Fe_2(Cr_2O_7)_3$. It is a brown hygroscopic mass, easily soluble in water. The solution hydrolyses on extensive dilution and becomes turbid on boiling, although if not too concentrated it becomes clear again on boiling. When the solid is heated at 100° it decomposes to some extent, and the decomposition is greater at higher temperatures. At 140° the chromate radical is largely decomposed and a black residue, only slightly soluble in water or hot concentrated hydrochloric acid, remains. On prolonged boiling with the acid it slowly dissolves, giving a green solution. These results differ from those of Calcagni.

Manganese Dichromate. Pure chromic acid solution was allowed to interact with excess of freshly precipitated manganous

carbonate, and after some time the solution was filtered through paper or asbestos. The products were identical. The dark red filtrate deposited a black residue on boiling or on allowing to stand for some time at room temperature. The solution contained MnO and CrO_3 in the ratio 1 : 1.90, and probably contains the compound $MnCr_2O_7$. All attempts to isolate this in the solid form were unsuccessful. When dried up in vacuum over sulphuric acid a solid only partly soluble in water was obtained, which gave on analysis (Treadwell and Hall, Vol. II., 1919, p. 149), MnO 21.55%, CrO_3 61.28%, H_2O (by difference) 17.18%. These correspond with $MnCr_2O_7$, $3H_2O$, but the product is unquestionably decomposed, part of the manganese being in the form of dioxide and part of the chromium in the form of sesquioxide. The solution obtained by treating this with water again decomposed on evaporation. When the original solution was evaporated by boiling it in a current of hydrogen, it remained clear until nearly dry, when a shining black solid quickly separated. This was the same as that obtained by evaporation in air. The concentrated solution did not crystallise in ice and salt; it froze in acetone and solid carbon dioxide and the solid remelted on warming to a clear solution. Attempts to prepare double salts with potassium chromate were unsuccessful; decomposition occurred and a mixture of potassium dichromate and manganese dioxide was obtained. A true dichromate of manganese has, therefore, not yet been obtained in a solid form.

SUMMARY.

A solid ferric dichromate of the composition $Fe_2 (Cr_2O_7)_3$ has been obtained and a manganese dichromate of the composition $MnCr_2O_7$ has been prepared in solution. Attempts to obtain the latter in the solid state, or in the form of a double salt with potassium chromate, were unsuccessful.

East London College,
University of London.

A THEORY ON ELECTRICAL CONDUCTIVITY OF METALS.

By S. PROCOPIU.

(Abstracted from the *Bulletin de l'Académie Roumaine*, No. 4, 1926, p. 93.)

I have previously attempted to show that Gruneisen's empyrical relation

(1) $$r = K.\,C.\,T$$

connecting electrical resistance, r, with absolute temperature T, and the specific heat of the metal, C, has a theoretical basis.

Taking into account the variation of the thermal energy, the following relation is obtained :

(2) $$r.\,(di)^2.\,\tau = C.\,dT.$$

in which *di* is the element of the electrical current and τ is the time between two molecular bombardments, C is the specific heat at constant volume per unit of mas.

One objection to this relation is that the differentials in (2) are of different orders, and this would give the final relation :

(3) $$r = \frac{2CT}{\Delta u.\,n^2.\,e^2.\,l}$$

in which the variable Δu is the speed of the electrons. This manner of expressing the relation is only permissible when Δu is not a differential.

From (1) we obtain

(4) $$r\,r.\,i.\,di\ \tau = C.dT$$

Here the differentials are of the same order but it will be noticed that the result of the calculation is the same.

A second objection may be raised by a consideration of equation (3) which shows that the resistance r. depends on the variation of the speed of the electrons *u*, that is, of the electrical field. This has not been confirmed by experiment. To avoid such a conclusion I have put forward the hypothesis that if the energy of radiation is emitted for a time τ, then Δu should be equal to unity. This hypothesis supposes that the mean free path, *l*, is independent.

It is thus obvious that the equation (3) holds, but that a perfect theoretical demonstration of Gruneisen's equation still remains to be shown.

Leon Brillouin (*Atomes et Electrons*, 1923), has given an interesting demonstration of the truth of this formula.

ON THE SYNTHESIS OF ELEMENTS.—ADDENDA.

By F. H. LORING.

On page 357 of the present volume of the *Chemical News* I state that "Volatibility may explain the difficulty of getting a proper spectrum of Te, as many compounds of Te boil at a comparatively low temperature." This should read : The volatility may explain the difficulty of getting spectra of Te and I (if present) as some of the compounds of Te boil at a comparatively low temperature, suggesting that under the added reducing action of the cathode-rays,

and the material being in a vacuum (not a high one, but pump kept continually running), Te (TeO_2 ?) and I may volatilise, considering the long exposure and the material possibly not adhering closely to the face of the anticathode.

In connection with the above see Kaye's "X-rays," section under the heading: Volatilisation of the Anticathode. I am not satisfied that the above is a complete explanation of the matter as the conditions are somewhat complex. Moreover, I think the range of oscillation was not as much as expected, and this would account for the non-appearance of the lines. That is to say, the exposure was reduced by not having a sufficient overlap. The vacuum in the tube was not very high, so I am investigating this phase of the problem as a contributory cause of the lines in question not appearing. There is one other point. By the expression "True wave-lengths" (p. 357), I mean the best values available.

ELEMENT OF ATOMIC NUMBER 61.

The announcement of the claim to the discovery of the element of atomic number 61 by Prof. B. Smith Hopkins, J. A. Harris and L. Yntema has been followed by the claims to its discovery by an Italian scientist, Prof. Rolla. The latter is stated to have identified the missing element spectroscopically after four years research on the subject and he proposes the name Florentium for it.

General Notes.

DETERMINATION OF FREE LIME IN HYDRAULIC CEMENT.

Calcareous hydraulic cements, such as Portland, are in widespread use, but very little accurate knowledge exists of the chemistry of the setting and hardening processes. While, however, the precise chemical formulæ of other compounds in the set product are debated, it is generally agreed that slaked time in a free condition is usually present, and that it has an important influence upon the properties of the cement. In particular, the resistance of cement to sea water, fire, and other forms of attack depends upon the proportion of free lime it contains. It is, therefore, of first importance that a reliable method should be devised for determining the free lime content.

Building Research Technical Paper No. 4 of the Department of Scientific and Industrial Research, dealing with a comparison of methods, is issued in response to a number of requests for information received by the Building Research Station. Ordinary analytical methods are not capable of distinguishing between free slaked lime in cement and the lime combined with silica and aluminia. Special methods are therefore necessary. Four such methods have been tested to determine their applicability to ordinary Portland, Portland-blast-furnace, high alumina and slag cements, both fresh and in set condition; three of the methods have been previously suggested as suitable for determining free lime, two being wet processes and one dry; the fourth, a calorimetric method, has been developed at the Building Research Station.

The paper is published by H.M. Stationery Office, price 6d. net.

INDUSTRY'S BURDEN.

The Federation of British Industries have been giving serious consideration to the financial aspects of the present industrial position and have especially considered whether there are any immediately practicable steps which His Majesty's Government could be asked to take, in order to assist in the restoration of national prosperity and the absorption into industry of the large numbers of workers who at present swell the ranks of the unemployed.

Representations in regard to specific points are being continually made by the Federation to the different Ministers of the Crown in charge of Departments. There is, however, one large question of principle of the highest importance which, in the opinion of the Federation, requires the personal consideration of the Head of His Majesty's Government; that is, the cumulative effect of legislative and other official provisions in impairing the competitive powers of British industry.

The task which has confronted British manufacturers since the war has been continuously to reduce their costs of production in order to be able to meet competition from foreign nations in the markets of the world. This task has been one of surpassing difficulty. The long period of deflation in connection with the return of this country to the gold standard undoubtedly entailed troubles for industry which were

accentuated by the opposite policy pursued by the Governments and financial authorities of competing nations. The decision of the Government to return to a gold standard was made at a time when the level of prices in this country has not yet been reduced to a competitive level, and thus in itself increased the difficulties under which British industry was suffering.

CANADA PROPOSES TO MAKE PIG IRON FROM BLACK SANDS.

The Natural Resources Intelligence Service at Ottawa reports that Mr. L. L. Simpson, engineer and chemist of Seattle, told the Victoria (B.C.) Board of Trade at a recent special meeting that a system has been invented whereby the black sands of the Coast Islands could be made to yield pig iron of high grade quality. Mr. Simpson stated that an experimental plant had been located and operated in Sedro-Woolley, Wash., for about a year, but it had been decided to come to British Columbia as this Province furnished the only large source of raw material, there being practically no black sand in the United States.

It was planned, said Mr. Simpson, to establish a plant costing $160,000, of about thirty-ton daily capacity and employing twenty to twenty-five men. An option had been taken on a site at Port Moody. The black sand could be obtained for $1.50 a ton, manufacturing costs totalled $25 and the finished pig iron would sell at $40 a ton.

The black said was made into briquettes by a secret process, and certain qualities in the sand resulted in a higher grade of pig iron than that obtained from ore, said the speaker.

It is a well-known fact that there are large areas of black sand on the Queen Charlotte islands, particularly Graham Island, and in the beach and river gravels of the Tulameen valley. Heretofore interest in the black sand deposits of British Columbia has been mainly on account of their gold content and at present operations of some magnitude are being carried on in the Tulameen valley for the recovery of gold and platinum from the black sands.

SEVENTEENTH ANNUAL EXHIBITION OF THE PHYSICAL SOCIETY AND THE OPTICAL SOCIETY.

This Exhibition, which is to be held on Tuesday, Wednesday, and Thursday, January 4, 5 and 6, 1927, at the Imperial College of Science and Technology, Imperial Institute Road, South Kensington, will be open in the afternoon (from 3 to 6 p.m.) and in the evening (from 7 to 10 p.m.).

On January 4 at 8 p.m., Prof. E. N. da C. Andrade will reproduce with contemporary apparatus a physical lecture of the early eighteenth century. On January 5, at 8 p.m., Mr. C. V. Drysdale will give a lecture on "Progress in Electrical Instrument Design and Construction," and on January 6, at 8 p.m., Mr. J. L. Baird will give a lecture on "Television." These lectures will be illustrated by lantern slides and experiments. Some 70 firms will exhibit scientific apparatus, and in addition there will be a group of non-commercial exhibits by Fellows of the Societies and others, including demonstrations of famous historical experiments in physics, recent research and effective lecture experiments.

It has been decided to open the Exhibition to the general public without tickets on the third day, January 6. On January 4 and 5 tickets of admission will be required.

We understand that invitations relating to January 4 and 5 have been given to the Institution of Electrical Engineers, the Institution of Mechanical Engineers, the Chemical Society, the Radio Society of Great Britain, the Rontgen Society, the Faraday Society and other scientific societies. Members of such societies should apply for tickets to the secretary of the society to which they belong. Others interested should apply direct to Professor A. O. Rankine, Imperial College of Science and Technology, South Kensington, S.W.7.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

At the monthly Council meeting on December 8, Lord Desborough, the President, in the chair, Mr. Luddington (chairman, Chemical Department), reported that the Consulting Chemist had submitted a list of samples analysed by him for members during the month of November. The Committee had considered the annual report for 1926 of the Consulting Chemist. This, with certain amendments, had been passed for publication in the next volume of the *Journal*. Dr. Voelcker had reported on the progress of the Fertilisers and Feeding Stuffs Bill, which was down for the third reading that day, and had presented the report on matters arising out of his correspondence.

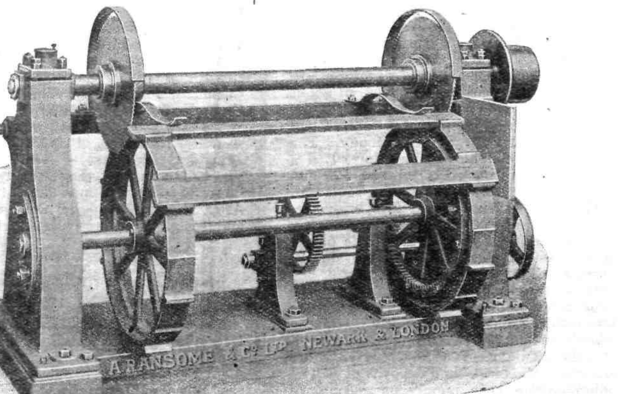
Cask and Barrel Making Machinery for all Purposes.

Messrs. A. RANSOME & CO., Newark-on-Trent, and 63, Queen Victoria Street, London, E.C.4.

In modern times, when manufacturers have to face world-wide competition and have, therefore, to produce their goods expeditiously and at the least possible cost, the aid of well-designed machinery has to be requisitioned.

Messrs. A. Ransome & Co., Ltd., the leading manufacturers of Patented and Improved Cask Making Machinery of all kinds, supply the needs in this respect of a large number of manufacturers engaged in a variety of trades. The containers of goods are as necessary as the goods themselves, and where the output is large, machinery of the most up-to-date kind is necessary to enable the casks, barrels, etc., to be rapidly and cheaply manufactured. It is surprising the variety of uses to which wooden vessels of divers shapes and designs are applied, and in fact a mere recital of them would fill a column or two of the *Chemical News*.

To start with, there are casks for the Chemical Industry, including its numerous branches. Casks or barrels for cement,



DOUBLE STAVE CROSS-CUT SAW, WITH SELF-ACTING FEED.

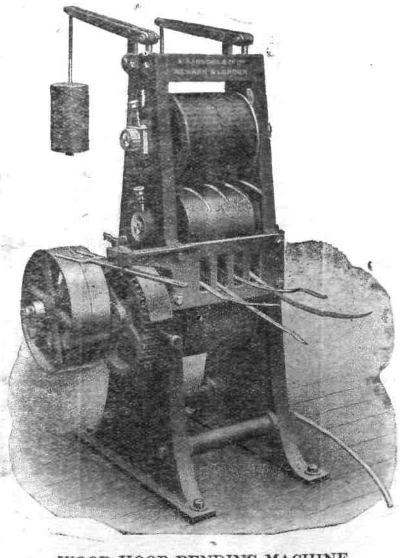
The saws in this machine have a dia meter of 16 inches, and are fitted to sleeves adjustable on the spindle for di fferent lengths of staves. As will be seen, the saws are guarded, and there is provided a spring pressure for holding the staves in position. Most importa nt, the machine is fitted with a *continuous feed*, by which the staves are carried past the saws and delivered at the other side of the machine by me ans of revolving carrier wheels, with projections upon which the staves are laid, as will be seen by the illustration.

petroleum, wines, oils of divers kinds, sugar, molasses, brandies, spirits of all kinds, beers, vinegar, paint, white lead, butter, margarine, etc., etc.

To take the breweries, chemical manufacturers, petroleum merchants and cement manufacturers alone, the number of casks or barrels required each year must be enormous. Millions of barrels are employed in the importation of apples and other kinds of fruit.

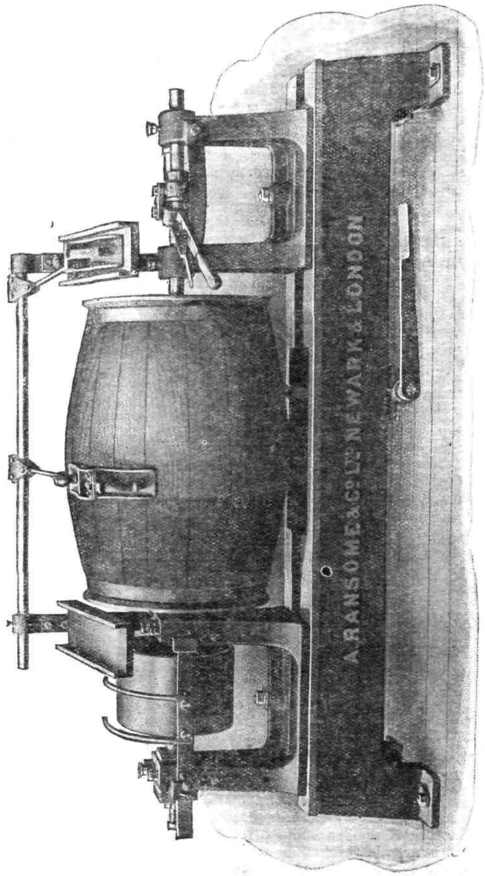
The wood mostly employed is oak, especially for holding liquids, but for various other purposes ash, beech, birch, and even poplar and other kinds of wood, are employed, especially where elaborateness and durability can be sacrificed to cheapness.

The firm of A. Ransome and Company supply machinery for every stage in the manfuacture of casks and barrels, and we have pleasure in giving illustrations of a few of the machines, which will prove interesting. Manufacturers in Great Britain or any part of the world, interested in these useful machines, would do well to write for definite particulars to Messrs. A. Ransome and Company, Ltd., Newark-on-Trent, or 63, Queen Victoria Street, London, E.C.4.



WOOD HOOP BENDING MACHINE.

The illustration is self-explanatory. The machine effects a great economy in the manufacture of wooden hoops of all kinds. As will be seen, several hoops are passed simultaneously under the Main Feed Rollers. The importance of the machine will be understood from the fact that the machine attended to by a lad, operates up to 12,000 hoops in eight hours.



CLEANING-OFF MACHINE.

The simple and efficient manner in which this machine does the work is obvious, while with an unskilled hand it will do more and better work thanhalf-a-dozen or more expert men could do without machinery.

PROCEEDINGS AND NOTICES OF SOCIETIES.

ROYAL INSTITUTION.

A general meeting of the Members of the Royal Institution was held on the afternoon of December 6, Sir Arthur Keith, M.D., LL.D., F.R.S., Treasurer and Vice-President, in the chair. The Chairman announced that the Managers had elected Professor Julian Huxley Fullerian Professor of Physiology. The special thanks of the Members were returned to Mr. Frank Scudder for his gift of a crystal model, nine lantern slides used by Sir Henry Roscoe in his lectures on Faraday, and a Franklin Medal in aluminium which belonged to Faraday; and to the Department of Scientific and Industrial Research for the gift of the whole of the apparatus and equipment used by Sir William Bragg in his researches on the X ray Analysis of Crystals.

Mr. W. H. Ballantyne, Mr. A. C. Eborall, Mrs. Eccles, Mr. W. C. Edwards, Dr. C. V. Drysdale, Commander J. O. Gawne, Mr. H. C. Holder, Miss McClean, Mr. A. J. Mundella, Dr. C. C. Murdock, Mr. E. A. Notcutt, Dr. Mata Prasad, Dr. M. Robertson, Mr. E. W. Rowntree, Mr. H. G. Spicer, Mr. W. A. S. Vardy, and Mr. C. P. Williamson were elected Members.

PHYSICAL SOCIETY.

At the meeting on November 26, 1926, at the Imperial College of Science, Professor O. W. Richardson, M.A., D.Sc., F.R.S., in the chair, the following papers were read :—

Electro-Endosmosis and Electrolytic Water Transport. By H. C. HEPBURN, B.Sc., Research Student, Birkbeck College.

ABSTRACT.

This paper gives the results of determinations of liquid transport produced by passing an electric current through aqueous solutions of copper sulphate divided perpendicular to the flow of electricity by a diaphragm of powdered glass. The probable factors that determine the liquid transport are investigated, over a wide range of concentrations, by an examination of the dependence of the flow at constant applied voltage and of the electric charge of the diaphragm on the electrolyte concentration, and also by a study of the relation between the flow per faraday and the dilution of the electrolyte.

The Input Impedances of Thermionic Valves at Low Frequencies. By L. HARTSHORN, A.R.C.S., B.Sc., D.I.C., Electrical Department, National Physical Laboratory.

ABSTRACT.

It is shown that accurate measurements of input admittance (or of input impedance) under various conditions can be made by means of the Schering Capacity Bridge. The input circuit is regarded as being equivalent to a condensed with a definite phase angle, ϕ, or " loss angle," $\delta = 90^\circ - \phi$, and the results are expressed by stating the effective capacity and the value of tan δ for each set of experimental conditions.

A series of measurements made on an *R* valve is recorded, and it is shown that the results are in good agreement with the theoretical investigations of Miller and Nichols. The theoretical investigation has been extended to allow for the effect of dielectric losses in the valve, since these were found by experiment to be rather large, and to have an appreciable effect on the capacity and phase angle of the input circuit.

It is shown that the effective capacity may vary from about 10 $\mu\mu$F. to 100 $\mu\mu$F. for an *R* valve, and the phase angle may vary from about 80° leading to 120° leading, depending mainly on the load in the anode circuit. Values of phase angle greater than 90° correspond to a negative resistance, or negative power factor, and occur when the load in the anode circuit is inductive. The variations of input capacity and phase angle with filament voltage, anode voltage, input voltage, and frequency are also investigated.

SOCIETY OF PUBLIC ANALYSTS.

An ordinary meeting of the Society was held at the Chemical Society's Rooms, Burlington House, on Wednesday, December 1st, 1926, Mr. E. Richards Bolton, President, being in the chair.

Certificates were read for the first time in favour of Messrs. Solomon Greenberg, F.I.C., Frank Crafer Ray, M.A., F.I.C., and Geoffrey Charles Matthews, B.Sc., A.I.C.

A certificate was read for the second time in favour of Mr. Stanley Grove Burgess, B.Sc., A.I.C.

The following were elected Members of

the Society:— Miss Gertrude Garland Andrew, B.Sc., Messrs. Charles Edward Barrs, F.I.C., Thomas Hedley Barry, Gordon Watson Douglas, B.Sc., Clarence Victor Ferriss, B.Sc., A.I.C., and Reginald Charles Pakes, B.Sc.

The following papers were read and discussed:—

Recent Advances in the Bacteriological Examination of Food and Water. By William G. Savage, B.Sc., M.D.

The four tests used to differentiate the high and low types of coliform organisms in water and their value as indicators of excremental contamination are discussed. As regards milk, the value of examining centrifugalised deposits for the tubercle bacillus is considered, and new tests for distinguishing pathogenic streptococci from those of bovine origin not injurious to man are described. An outline is given of the types of bacteria causing food poisoning, together with details of laboratory methods, and the examination of canned foods is discussed.

On the Presence and Detection of Furfural in Vinegar. By L. H. Lampitt, D.Sc., F.I.C., E. B. Hughes, M.Sc., F.I.C., and L. H. Trace, B.Sc., A.I.C.

In the distillation of malt vinegar or wine vinegar furfural is produced by the acid hydrolysis of the pentosans contained in the vinegar; this explains the presence of furfural in commercial distilled vinegar. Added caramel in vinegar will only give the furfural it originally contained as such.

A modified aniline acetate test has been devised wherein the rose-coloured furfuraniline is extracted by an immiscible solvent, amyl alcohol. Thus dark-coloured vinegar may be tested for furfural without distillation. The test is satisfactorily quantitative.

The Rapid Determination of Opium in Stomach Contents. By E. R. Dovey, A.R.S.Sc., F.I.C.

A standard solution is made from ordinary prepared opium which has itself been standardised to contain 10 per cent. of morphine and 5 per cent. of meconic acid. A measured quantity of the stomach washings (which have given the reactions for morphine and meconic acid) are treated successively in a Nessler cylinder with dilute hydrochloric acid, mercuric chloride solution, and ferric chloride solution, and the resulting colour is matched with that given by the standard under the same conditions. The addition of the mercuric chloride inhibits the formation of any coloration with thiocyanic acid in the opium.

A Rapid Method for the Sorting of Butters and Margarines. By C. H. Manley, M.A., F.I.C.

The method depends upon the butyric acid content of butter fat. The filtered fat is saponified, the soap solution acidified with sulphuric acid, and the insoluble fatty acids filtered off under specified conditions. The excess of sulphuric acid in the filtrate is neutralised (methyl orange as indicator) and the titration with standard alkali continued to neutrality, with phenolphthalein as indicator. The difference between the result and that obtained in a blank test affords a measure of the soluble fatty acids. The neutral solution may be used for determining the Kirschner value.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

The Design of City Distribution Systems, and the Problem of Standardisation. By J. R. Beard, M.Sc., Member, and T. G. N. Haldane, B.A., Graduate.

Summary.

It is believed that the future will bring a rapid growth of load and that this makes the present a suitable moment to analyse city distribution methods, settle a policy of development, and consider the possibility of standardisation.

The main object of the paper is, therefore, to design a system suitable for adoption as a standard and to consider how far existing systems may gradually be brought into line with it.

The various sections of a city distribution system are reviewed in sequence from the consumer to the main transmission system (or local power station) under the following headings, particular attention being given to the design of a system lay-out which facilitates expansion to deal with growing load:—

(a) The type and voltage of current to be delivered to the consumers.
(b) The general lay-out of the low-voltage distribution system.
(c) The general lay-out of the high-voltage distribution system for feeding the low-voltage system through transforming centres.
(d) The voltage to be adopted for supplying the transforming centres from the main substations on the transmission system.
(e) The size and spacing of transforming centres.

The desirable characteristics are then summarised so as to outline the proposed "standard" system. Suggested standards are also laid down for the capacity of the individual parts in areas of different type and load density.

The above is followed by three short studies, based on the detailed calculations necessitated by the main investigation. These deal with (i) the relative costs of the different elements of the distribution system, (ii) the effect of load density on the cost of distribution, and (iii) the relative costs of direct-current and alternating-current distribution.

In conclusion, some consideration is given to the general question of bringing existing city distribution systems into line with the proposed standard system with the object of attaining, ultimately complete standardisation of distribution throughout the country.

Conclusion.

In conclusion the authors feel that their investigations indicate that not only is the adoption of a standard system for all future extensions a matter of vital importance to eletcricity supply undertakings, but that a great deal moer can be done than is commonly supposed in modifying and adapting existing systems so as to achieve some of the main benefits of a standard system.

These conclusions are all based solely on *a consideration of the self-interest of the* electiricity supply industry, but similar ocnelusions would uudoubtedly apply if the subject were approached from the staudpoint of the manufacturer. Indeed, the advantage of standardisation in facilitating *mass production must be so great that the* authors venture to suggest to manufacturers that it might be worth their while to cooperate with the electricity supply industry in a vigorous effort to establish standadrisation. If, for example, manufacturers could offer some immediate advantage to the cousumer as regards the purchase of staudard apparatus, there can be no doubt that this would greatly influence supply undertakings in making such chauges as are necessary to bring existing systems into liue with the standard system.

•As it is impossible in a paper of this type to make personal acknowledgment to those who may recognise ideas peculiarly their own, the authors wish to express their general obligation to all those, both in this country and abroad, whose work has made the present paper possible.

DETERMINATION OF ZINC OXIDE IN BRASS.

By B. S. Evans, M.C., M.B.E., Ph.D., B.Sc., F.I.C., and H. F. Richards, B.Sc., B.Sc.(Eng.), A.R.S.M., Member.

(*Communication from the Research Department, Woolwich.*)

Institute of Metals, March, 1926.

The method described in this paper was worked out in an attempt to account for the presence of certain inclusions in samples of brass. The only method hitherto available appears to be that of West, in which the oxide is reduced by heating the sample in a current of carbon monoxide, the resulting carbon dioxide being absorbed and weighed; this method has undesirable features, notable among which is the use of large volumes of the highly poisonous carbon monoxide; in addition to this, however, it seemed to be impossible to bring the blank to manageable proportions—in fact, there was a certain amount of evidence to show that the carbon monoxide underwent a slight amount of autoxidation, carbon being deposited on the walls of the furnace tube; moreover, the CO + ZnO reaction being reversible, West's method requires a high rate of flow of gas, and also is useless in the presence of tin or nickel. *In consequence a new method was sought.* T .Turner has shown that the ordinary method of determining oxygen in copper, by passing hydrogen over the heated sample, is inapplicable in the presence of zinc, owing to the volatilisation of the *latter and its reduction (in the cooler parts* of the furnace) of the water formed; it was, however, found by the authors that this back reaction could be suppressed by the addition of certain metals, notably copper and nickel. That the action of the metal thus introduced is simply one of absorbing, and thus lowering the vapour pressure of, the zinc is evidenced by the fact that the metal need not be in contact with the sample at all, and that, to be successful, sufficient metallic surface must be present to prevent entirely any passage of zinc beyond it; in other words, if zinc be removed from the system, thus disturbing the equilibrium, the reactiou will go in the direction which produces zinc—*i.e.*, zinc oxide will be reduced by hydrogen.

The following are the details of the process.

APPARATUS.

This is a modification of that described by R .H. Greaves. For convenience of reference a description of it is given below. It consists of :

(*a*) A source of hydrogen ,a large Kipp's apparatus containing pure zinc, 50 per cent. hydrochloric acid + ferrous ammonium sulphate).
(*b*) Glass beads saturated with 10 per cent. silver nitrate.
(*c*) Pumice saturated with 4 per cent. lead acetate.
(*d*) Pummice saturated with 4 per cent. mercuric chloride.
(*e*) 50 per cent. sodium hydroxide.
(*f*) Concentrated sulphuric acid.
(*g*) Phospborus pentoxide.
(*h*) Electric tube furnace containing copper gauze.
(*i*) Electric tube furnace containing platinum asbestos.
(*j*) Soda lime towers.
(*k*) Concentrated sulphuric acid.
(*l*) Phosphorus pentoxide tower.
(*m*) Experimental electric tube furnace.
(*n*) Glass-stoppered U-tube glass beads + phosphorus pentoxide.
(*o*) Guard tube of concentrated sulphuric acid.
(*p*) Graduated aspirator containing water for measuring rate of flow of gas.

Two rolls of copper gauze (strips of fine gauze 30 in. × 5 in. are suitable for this) are prepared, 5 in. in length, tightly rolled, and of such a diameter that they will just slide into the furnace tube; they are each fastened with a strand of thin copper wire and provided with a loop of iron wire at one end, so that they may easily be withdrawn from the furnace by a hooked rod; copper wire is also rolled into balls which will just fit the furnace tube. The two rolls and two of the balls are deoxidised by keeping for some hours at 1,000° C. in a current of hydrogen.

BLANK.

The silica boat which is to be used to hold the sample is now placed in the middle of the furnace tube, on either side of it one of the deoxidised copper rolls, and on either side of these again one of the two balls of wire; the stopper at each end of the tube is protected from the heat by a plug of asbestos. The apparatus is now connected up and the hydrogen turned on; when the air has been swept out the current is switched on and the furnace taken up to 1,000° C., and maintained at that temperature ;after 2 or 3 hours the phosphorus pentoxide tube is weighed, and this weighing is repeated at intervals of 2 to 3 hours until the gain in weight per litre of gas passing has reached a constant value. The rate of flow of the gas, which should be about 1 litre per hour., is measured from time to time. The gain in weight per litre of hydrogen should not exceed 0.4 mg. if the copper has been properly deoxidised.

ESTIMATION.

The blank having been satisfactorily determined, the furnace is allowed to cool, and when quite cold, the wire ball and roll at one end having been withdrawn, the boat is removed and the weighed sample (this should be a lump of about 80 grm.) placed in it; the boat, gauze roll, and ball are then replaced, the appratus connected up, and the hydrogen turned on. It is desirable to expose the deoxidised roll, etc., as little as possible to the air; these operations should therefore be conducted quickly. Hydrogen is passed through the cold apparatus, the U-tube being weighed from time to time, until the weight remains constant. It is advisable to take a whole day for this, so as to be able to have a clear day for the estimation. The temperature is finally raised to 980° C. (the time and rate of flow of the hydrogen being noted), and maintained at this point until the gain in weight of the U-tube again reaches a steady figure, which should be the same as that found for the blank. The total gain in weight of the U-tube—(blank × number of hours run) represents the weight of water formed from the zinc oxide.

The following test estimations were carried out with different weights of zinc oxide :

Weight of ZnO taken	Weight of H_2O obtained	Duration of Experiment	Blank	Net weight of H_2O	Theoretical weight of H_2O	Weight of ZnO recovered
0.2000	0.0448	2 hours	0.0008	0.0440	0.0442	0.1991
0.1550	0.0327	2 ,,	0.0008	0.0319	0.0331	0.1443
0.1000	0.0245	3 ,,	0.0012	0.0233	0.0221	0.1048

The error is somewhat large, but if, bearing in mind the very small amount of ZnO present in brass, these figures are calculated as percentage on a 50-grm. sample it become negligible.

Zinc added	Zinc found
%	%
0.40	0.40
0.30	0.29
0.20	0.21

A large number of early experiments gave low results, owing to lack of appreciation of the amount of copper or other metal required to diffuse almost as readily against the stream as with it. It may be laid down as an invariable rule that if any zinc deposit is found on the walls of the furnace tube the estimation is worthless, or at any rate doubtful.

Several metals were tried as retaining agents; of these copper was by far the best. Nickel and Monel metal are capable of giving fair results with pure zinc oxide, but are unable to retain all the zinc distilling from a sample of brass. Iron appears to be practically useless.

A large number of attempts was made to prepare a standard sample of brass containing a known amount of zinc oxide in order to test the process further. These were uniformly unsuccessful; it was only with the utmost difficulty that any oxide could be got into the brass at all, and then it was so extremely unevenly distributed that the sample, even if its oxide content were known, was valueless as a standard.

Evidence as to successful penetration of the brass by the hydrogen, and as to the complete rednction of the zinc oxide and removal of the water formed, had therefore, necessarily, to be indirect in character.

It was shown by Blount that melted copper is completely deoxidised by hydrogen. Archbutt further showed that copper even at red heat is completely deoxidised by hydrogen if time be allowed for penetration. West concluded that carbon monoxide completely removed the oxygen from brass at 1050° C. There seemed, therefore, no reason to anticipate any difficulty in the removal of oxygen from brass under the conditions of the estimation described (*i.e.*, brass molten and time about 2 hours). A sample of brass was prepared and allowed to solidify and, while still molten, zinc oxide was vigorously stirred in until the brass became pasty. The brass was allowed to cool and ¼ in. sections were cut horizontally :—

(*a*) Close to top.
(*b*) About midway.
(*c*) Close to bottom.

These sections, on being etched, showed a fair number of inclusions in the top section, few in the middle section, and none in the bottom section.

Zinc oxide was then estimated in the three sections according to the method described, with the following results :—

	Oxygen %
(*a*)	0.024
	0.025
(*b*)	0.005
(*c*)	Nil

Sample (*b*) on being put back into the furnace and resubjected to the process yielded no more water.

A sample of brass prepared as above and containing zinc oxide inclusions was treated as for estimation of oxygen, but the temperature was kept below melting point of brass; after treatment the sample was cut into small pieces and examined microscopically; the inclusions had been reduced, leaving empty holes. In one case there was a hole right through a piece. Further treatment of the pieces produced no more water although fresh surfaces had been exposed. This shows that penetration by hydrogen is complete.

The following table represents a series of early experiments with zinc oxide on the comparative value of different metals for suppressing the back reaction :—

	ZnO taken	Metal used	Water collected	Blank	Net weight of water	Calculated weight of H_2O	Percentage recovered
(a)	0,2000	Nickel	0.0402	0.0016	0.0386	0.0444	87.0
(b)	0.2000	Monel metal	0.0431	0.0012	0.0419	0.0444	94.5
(c)	0.2000	Copper	0.0433	0.0010	0.0423	0.0444	95.5
(d)	0.2000	Iron	0.0053	0.0012	0.0041	0.0444	9.0
(e)	0.2000	None	0.0076	0.0012	0.0064	0.0444	14.5

This series brings out clearly the superiority of copper or metal containing copper; it also offers confirmation of Turner's conclusions and proves the uselessness of iron in this respect. It is worthy of note that in experiments (d) and (e), as well as the others, the boat was found to be empty after the experiment.

THE UNIVERSITY OF SYDNEY.

Appointments.

Viscount Chelmsford, the Agent-General for New South Wales, announces the following appointments by the Senate of the University of Sydney:—

Professor of Philosophy—Mr. John Anderson, M.A., of the University of Edinburgh (in succession to the late Professor B. Muscio).

Professor of Psychiatry—Dr. William S. Dawson, of Maudsley L.C.C. Hospital, Denmark Hill, London (in succession to Professor Sir John Macpherson).

Lecturer in Pharmacy—Mr. Horace Finnemore, B.Sc., F.I.C., F.C.S., of Guy's Hospital Medical School, London(in succession to Mr. S. H. Stroud).

Lecturer in Chemistry—Dr. Thomas Iredale, of Armstrong College, Newcastle-on-Tyne (in succession to Associate Professor J. A. Schofield).

THE CHEMICAL SOCIETY.

The Library of the Chemical Society will be closed for the Christmas Holidays, at 1 p.m. on Thursday, December 23, and will re-open at 10 a.m. on Wednesday, December 29.

NOTICES OF BOOKS.

Principles of General Chemistry. By Stuart R. Brinkley, Assistant Professor of Chemistry, Yale University. Pp. X + 478. Price 15s. London: The Macmillan Company, Ltd.

Chemistry is a science with such varied divisions and sub-divisions, that in recent years the prolific authors of works on chemistry have deemed it advisable to specialise in some particular branch, and so a work like that before us, which gives the salient principles of general chemistry is worthy of special mention and appreciation. Primarily intended for students who have had a preparatory school course in chemistry, the work will be found very useful by such, but the book is one which any intelligent knowledge-seeking member of the public can read and re-read with pleasure and advantage. There are several illustrations, a useful index, and each chapter is followed by question exercises which will enable the student or other reader to measure the extent of his own knowledge of the matters dealt with in each chapter.

Laboratory Manual (arranged to accompany Principles of General Chemistry). By Stuart Brinkley, and Edwin B. Kelsey. Pp. XIV. + 160. Price 6s. 6d. London and New York: Macmillan and Company.

As a companion book to an important work, and as its title indicates, the present work deals in a practical manner with laboratory experiments, for which full and explicit instructions are given. Given the necessary apparatus and materials, the student can, by aid of the book, "go ahead," taking care not to terrorise his neighbours with explosions and other mishaps that attend the efforts of over-zealous amateurs.

Catalysis in Theory and Practice. By Eric K. Rideal (Owen Jones Lecturer on Physical Chemistry, Cambridge University), and Hugh S. Taylor, Professor of Physical Chemistry, Princeton University, U.S.A. Pp. XVI. + 516. Price 20s. net.

The authors pay a just tribute to the varied experiments and pronouncements of Berzelius about, 1836, who seems to have not only experimented but was an assiduous enquirer and a somewhat prolific writer on chemical subjects. The results of various other enquirers and experimenters are given in the "Early History," Chapter I., which occupy about a dozen pages. Chapters II., III., IV., and V. are devoted to criteria of catalysis homogeneous reactions, heterogeneous reactions and promoters. Procession and oxidation, hydrogen and hydrogenation, catalysis and nitrogen fixation, colloidal catalysts, etc., follow on in due order. The book contains many useful illustrations.

FORTHCOMING EVENTS.

ROYAL INSTITUTION.

The following lecture arrangements at the Royal Institution before Easter next year were announced at the general meeting on Monday, December 6th. The christmas course of six lectures for juveniles will be delivered by Professor A. V. Hill, on "Nerves and Muscles: How We Feel and Move," commencing on December 28, at 3 p.m.

On Tuesdays, at 5.15, beginning on January 18, there will be two lectures by Professor R. Whytlaw-Gray on "Smokes as Aerial Disperse Systems"; six by Professor Julian Huxley, Fullerian Professor of Physiology, on "Problems of Animal Growth and Development'; two by Dr. G. Shearer on "X-rays and the Chemical Molecule"; and two by Professor J. W. Cobb, on "Some Properties of Coke."

On Thursday, January 20, at the same hour, Mr. John R. H. Weaver will give the first of two lectures on "Romanesque and Early Pointed Architecture in Spain." These will be followed by three lectures on Thursday afternoons by Sir William Bragg on "Accoustical Problems treated by Lord Rayleigh"; three by Professor John Garstang on "The Progress of Hittite" Studies: two by Mr. J. Guild on "Colour Measurement and Standardisation"; and two by Mr. Harold J. E. Peake on "The Beginnings and Early Spread of Agriculture."

On Saturday afternoons at three o'clock, Professor E. W. Tristram will give two lectures on "English Mediæval Wall-Painting," commencing on January 22. On succeeding Saturday afternoons there will be three lectures by Mr. Walter de la Mare on (1) "Craftsmanship in Verse"; (2) "'Atmosphere' in Fiction"; (3) "The Supernatural in Fiction"; three with musical illustrations by Dr. McEwen on "Beethoven"; and four by Sir Ernest Rutherford on "The Alpha Rays and their Application to Atomic Structure."

The Friday Evening Meetings will begin on January 21, when Sir William Bragg will deliver a discourse on "Tyndall's Experiments on Magne-Crystallic Action." Succeeding discourses will probably be given by Professor E. P. Cathcart, Captain T. L. Eckersley, Dr. Ernest Law, Sir Josiah Stamp, Professor E. Hatschek, Professor C. T. R. Wilson, Sir Ernest Rutherford, and other gentlemen.

CANADIAN PATENTS ALLOWED.

(Filed at the Patent Record Office, Ottawa, Canada.)

305,837. — Ammonia synthesis. — Lugi Casale, Rome, Italy. November 16th, 1926. Filed August 25th, 1925.

A process for the catalytic synthesis of ammonia under pressure in which the reacting gases hydrogen and nitrogen containing gaseous impurities, such as carbonic oxide, are free therefrom by reaction with excess of ammonia gas prior to passing as a hydrogen-nitrogen or hydrogen-nitrogen ammonia mixture to catalysis.

308,080.—Hydrocarbon oil conversion.—Joseph Francis Donnelly, Lemont, Illinois, U.S.A. November 16th, 1926. Filed 7th November, 1925.

A process for the conversion of hydrocarbon oils, which consists in heating a mass of relatively heavy hydrocarbon oil to a cracking temperature under a pressure sufficient to prevent vaporisation thereof, discharging said heated oil into a zone of lower pressure, and simultaneously introducing a regulated supply of a cooling agent into said zone of lower pressure in such a manner as to substantially avoid total decomposition and affect the desired dissociation of said heated oil.

308,246.—Production of Phosphorus, etc.—I. G. Farbenindustrie Aktiengesellschafe, Frankfurt a.M., assignee of Gustav Pistor, Griesheim on the Main, and Ernst Borsbach, Bitterfeld-Sandersdorf, all in Germany. November 16th, 1926. Filed 13th November, 1925.

Process for the production of pure phosphorus, which consists in passing the hot crude gases issuing from the phosphorus furnace, directly through a flue dust chamber which is maintained at a temperature above the dew point of phosphorus and is provided with devices for the electrical separation of dust.

Process as set forth above, in which for the purpose of obtaining pure phosphorus pentoxide or phosphoric acid, combustion air is admitted to the gas mixture consisting of phosphorus vapour and carbon monoxide and freed from flue dust by electrical means, and the resulting gases are conducted to a condensation plant.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

29,989.—I. G. Farbenindustrie Akt.-Ges.—Apparatus for discharging liquids. November 26th.

30,079.—I. G. Farbenindustrie Akt.-Ges.—Manufacture of dyestuffs. November 27th.

30,084.—Distillers Co., Ltd.—Production of organic acids, etc. November 27th.

29,460.—I. G. Farbenindustrie Akt.-Ges.—Manufacture of monocarboxylic acid. November 22nd.

Specifications Published.

261,139.—Harris, J. E. G., Wylam, B., Thomas, J., and Scottish Dyes,

Ltd.—Intermediates, dyes, and dyeing.

261,455.—Landman, M. L.—Manufacture of bacterial preparations.

258,574.—Farbwerke Vorm. Meister, Lucius & Bruning.—Manufacture of derivatives of benztnthrones.

240,801.—Grasselli Chemical Co.—Processes and apparatus for making sulphur dioxide and sulphuric acid.

261,559.—I. G. Farbenindustrie, Akt.-Ges.—Manufacture and production of hydrocyanic acid.

Abstract Published.

259,395.—Barium oxide and hydroxide.—Hill, B. P., and Blaydon Manure & Alkali Co. (1877) ,Ltd., Blaydon-on-Tyne.

Barium oxide and hydroxide are obtained from barium carbonate by distributing the finely divided carbonate throughout a very hot gaseous phase. The carbonate may be blown into a furnace into the path of the gaseous products of combustion of pulverised coal, crude oil, or gas; or it may be introduced in admixture with pulverised coal; or it may be carried into the combustion chamber by the air blast feeding a fuel burner; or it may be allowed to fall through a rising flame from the fuel. The semi-fused residual product, which may contain some barium hydroxide in addition to barium oxide and fuel ash, is collected in a dust chamber or by means of a cyclone separator or an electrostatic precipitator. On extracting with hot water a solution of barium hydroxide is obtained, from which crystals of the hydroxide may be formed. The reaction furnace may comprise a vertical or horizontal combustion chamber, and recuperators or regenerators may be provided to pre-heat the air necessary for combustion of the fuel.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

KENBAR.

472,690.—Chemical substances used in manufactures, photography or philosophical research and anti-corrosives.—John Barker and Co., Ltd., 83, Kensington High Street, London W.8.

474,198.—Illustration of a Tower and the words EIFFEL TOWER, and the letters L and P for chemical substances used in manufactures, photography, or philosophical research, and anti-corrosives.—L. Le Personne & Company, 99, Cannon Street, London, E.C.4. December 1st, 1926.

ALOXIT.

474,228.—Chemical substances used in manufactures, photography or philosophical research and anti-corrosives.—Robert Ernest Martin, 1b, Stationplein, Rotterdam, Holland. December 1st, 1926.

CASOSIL.

473,966.—Chemical substances prepared for use in medicine and pharmacy.—Johann Abraham von Wulfing, 231, Friedrichstrasse, Berlin W., Germany. December 1st, 1926.

FOR SALE.

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FOR SALE.

Journals of the Chemical Society, 1915, £1; 1924, 1925, 10s. each; also *Chem. Soc. Abstracts*, 1924, 1925, 12s. each. All complete with indices.

Box H. E., c/o *Chemical News*, Merton House, Salisbury Square, E.C.4.

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"The Chemical News,
Merton House, Salisbury Square,
London, E.C.4 (England).

THE STRUCTURE OF SODIUM.

By HAWKSWORTH COLLINS, B.A., (Camb.)

For reasons which were published in the *Chemical News* several years ago the structure of sodium was given as follows :—An atom of sodium is formed by the union of one atom of boron with one of carbon. Seven reasons were stated for this conclusion :—

1. The atomic weights of B, C and Na are 11, 12 and 23 respectively; and 11 + 12 = 23.

2. If three valencies of C combine with the three of B, the fourth would be free, causing sodium to be a monad. Of course atomising bonds which are not chemically evident must have also come into play, otherwise Na would be merely a chemical compound, boron-carbon.

3. The number 11 can be split up into three parts, 7 + 1 + 3, from each one of which (representing Li, H and H_3 respectively) it is known that one valence emanates. Also 12 can be split up in a uniform manner into four parts, 7 + 1 + 3 + 1, from each of which one valence emanates; so that the atomic weights are definitely connected with the valences.

4. Whenever there is a free portion H + H_3 (helium) the element is a non-metal; *and when there is no such free portion, as* in sodium, the element cannot act as a non-metal.

5. The explanation of the Odd and Even Rule follows, for, since 1, 3, 7 and 23 are *all odd numbers, the sum* of an even number of odd numbers is an even number, and the sum of an odd number of odd numbers is an odd number.

6. Electro-negative valences emanate only from the metallic parts of non-metals. This matter has frequently been explained in the *Chemical News*, and it demonstrates the reasons why boron is monobasic and diacidic, why carbon is dibasic and diacidic, and why sodium is monacidic. The word monacidic means that the electro-positive valence of Na combines with an acidic or electro-negative element.

7. A similar state of affairs has been shown to exist in almost all other elements. The only known exceptions to the Odd and Even Rule are nitrogen, zinc and cadmium, the two latter because they contain N. The fact that these are exceptions does not upset the conclusions arrived at, because there is no reason why *all* elements should have been built up in exactly the same manner.

All the above reasons for the given structure of sodium have frequently been demonstrated in the *Chemical News* in conjunction with similar reasons for the structures of the other elements.

This constitution for sodium will now be proved to be correct by means of three other absolutely independent series of experimental data, *viz.*, Specific Gravity, Heat of Formation, and Magnetic Rotation, none of which were originally employed in the discovery of its structure.

The manner of proof will be as follows:— The Relative Volumes of the element will be demonstrated by means of Specific Gravity and Atomic Weight. Each volume will be shown to be capable of splitting up into parts, which have *already* been shown to be volumes of boron and carbon. Then the Laws of Heat of Formation and Magnetic Rotation will be shown to corroborate the volumes.

The structure of Na was demonstrated in the *Chemical News*, 1924, CXXVIII., 161: but, as it is one of the exceedingly important elements, and since it is hoped that the method of placing the facts before scientists has been greatly improved by experience, it is considered advisable to re-state the evidence concerning the structure of this element with many additional experimental facts, before proceeding with other elements.

TABLE I.

THE RELATIVES OF SODIUM.

	Na		B		C
(8)	23.73 (uncombined atom)	=	15.73	+	8.0
(9)	11.865 (combined atom)	=	3.865	+	8.0
(9A)	9.54 (part of an atom	=	3.865	+	5.675

9.54 (Na) has previously been shown to be a constituent part of Al, Si, P and S. 3.865 (B) was demonstrated in the last paper.

TABLE II.

EXPERIMENTAL DATA ILLUSTRATING TABLE I.

	Relative Volume.	Theor. S.G. at 15° C.	Obs. S.G.	
(10)	Na 23.73	0.97	0.97	Troost
(11)	NaCl 11.865 + 15.085	2.17	2.17	20° Kaye
(12)	NaBr 11.865 + 23.09	2.95	2.952	Schiff
(13)	$NaBr.2H_2O$ 11.865 + 23.09 + 2(14.03)	2.20	2.176	20° Nostrand
			2.34	Playfair
(14)	Na_3AsO_4 3(11.865) + 19.58 + 7.53 + 4.45 + 2(2.51)	2.88	2.86	21° Stallo
(15)	$Na_3AsO_4.12H'_2O$ same + 12(14.03)	1.763	1.762	Schiff
(16)	Na_2CO_3 2(11.865) + 8 + 7.53 + 2(2.51)	2.40	2.407	Favre
(17)	$NaHCO_3$ 11.865 + 5.76 + 8 + 7.53 + 2(2.51)	2,200	2.205	Schroder
			2.192	Playfair
(18)	$NaNO_3$ 11.865 + 3.8 + 3(7.53)	2.222	2.2256	Karsten
(19)	$Na_2SO_4.6H'_2O.4H_2O$ 2(11.865) + 15.53 + 2(7.53 + 2.51) + 6(14.03) + 4(18.02)	1.493	1.492	20° Pettersson
(20)	NaOH 11.865 + 2.51 + 5.76	1.986	1.723	Smith
			2.130	Filhol
(21)	$Na_2S_2O_3.4H'_2O.\ H_2O$ 2(11.865) + 2(15.53) + 7.53 + 4.45 + 2.51 + 4(14.03) + 18.02	1.73	1.734	Schiff
(22)	Na_3PO_4 3(11.865) + 16.87 + 4.45 + 3(2.51)	2.545	2.536	17°.5 Mohr
(23)	$Na_3PO_4.12H'_2O$ same + 12(14.03)	1.633	1.6645	Dufet
			1.622	Playfair

(24)	$Na_2HPO_4.12H'_2O$ 2(11.865) + 5.76 + 16.87 + 4.45 + 3(2.51) + 12(14.03)	1.58	1.586	8° Kopp
(25)	$Na_2SiO_3.8H'_2O$ 2(11.865) + 13.83 + 4.45 + 2(2.51) + 8(14.03)	1.67	1.666	18° Clarke
(26)	$NaCO_2H$(formate) 11.865 + 8 + 7.53 + 2.51 + 5.76	1.907	1.907	Schroder.
(27)	$NaH_2PO_4.H'_2O$ 11.865 + 2(5.76) + 16.87 + 4.45 + 3(2.51) + 14.03	2.06	2.0547	Dufet
(28)	$NaH_2PO_4.2H'_2O$ same + 2(14.03)	1.94	1.915	Joly
(29)	$NaCO_2CH_3.3H'_2O$ 11.865 + 8 + 7.53 + 2.51 + 16.42 + 5.76 + 3(14.03)	1.444	1.456	Schroder
			1.420	Buignet
(30)	$Na_4P_2O_6.10H'_2O$ 4(11.865) + 2(14.56) + 2(4.45) + 4(2.51) + 10(14.03)	1.823	1.8233	Dufet
(31)	$Na_2HAsO_4.12H'_2O$ 2(11.865) + 5.76 + 19.58 + 7.53 + 3(2.51) + 12(14.03)	1.73	1.736	Playfair
(32)	$NaH_2AsO_4.H'_2O$ 11.865 + 2(5.76) + 19.58 + 7.53 + 3(2.51) + 14.03	2.53	2.535	Schiff
(33)	$Na_2S_2O_6.2H'_2O$ 2(11.865) + 2(15.53) + 2(7.53) + 2(4.45 + 2.51) + 2(14.03)	2.165	2.175	11° Baker
(34)	SiC 7.13 + 5.675	3.12	3.12	15° Nostrand
(35)	Li_2C_2 5.46 + 6.21 + 2(5.675)	1.65	1.65	18° Nostrand
(36)	BaC_2 29 + 8 + 5.675	3.75	3.75	Nostrand
(36A)	SrC_2 23.98 + 2(5.675)	3.17	3.19	Nostrand
(37)	B_2O_3 2(15.73) + 3(2.51)	1.80	1.803	Davy
(38)	BCl_3 15.73 + 3(23.01)	1.387	1.35	Wohler
			1.434	0° Nostrand

TABLE III.

	Heat of Formation of Na.	Orig. Vol.		Rel. Vol. in combination at 15° C.		Change of Volume
(39)	32747 = 120 × 11.865 × 23	23.73	=	11.865	+	11.865
(40)	aq. 32747					
(41)	aq. 31234					

TABLE IV.

INTERPRETATION OF THOMSEN'S EXPERIMENTS.

	Heat of Formation.		Theor.	Obs.	
(42)	$Na_3,As.O_4$ 3(32747) − 35100 + 32341 + 71515 + 2(96155)	=	359307	360800	
	(corresponds with Nos. 14 and 15)				
(43)	$Na_2.C.O_3$ 2(32747) − 13855 + 32341 + 2(96155)	=	276290	273700	
				278280	aq.
	(corresponds with No. 16)				
(44)	$Na.H.C.O_3$ 32747 − 15800 − 13885 + 32341 + 2(96155)	=	228243	227700	
	(corresponds with No. 17)				
(45)	$Na.N.O_3$ 32747 − 23300 + 3(32341)	=	106470	110700	
	(corresponds with No. 18)				
(46)	$Na_2.O_2.SO_2$ 2(32747) + 2(96155) + 0	=	257804	257510	
				257970	aq.
(47)	$S.O_2$ 6217 + 2(32341)	=	70899	71080	
(48)	$Na_2.S.O_4$ 2(32747) + 6217 +				

	2(32341) + 2(96155)	= 328703	328100	
	(corresponds with No. 19)			
(49)	Na.O.H 32747 + 96155 − 24350	= 104552	102700	
	(corresponds with No. 20)			
(50)	$Na_2.S_2.O_3.4H'_2O.H_2O$ 2(32747) + 2(6217) + 32341 + 71515 + 96155 4(3205) + 0	= 265119	265070	
	(corresponds with No. 21)			
(51)	aq.$Na_3.P.O_4$ 3(32747) − 8593 + 71515 + 3(96155)	= 449628	452400	
	(corresponds with Nos. 22 and 23)			
(52)	aq.$Na_2.H.P.O_3$ 2(31234) − 24350 − 8593 + 71515 + 2(96155)	= 293345	294250	
	(corresponds with part of No. 24)			
(52A)	aq.$Na_2.H.P.O_2$ 2(31234) − 24350 − 8593 + 71515 + 96155	= 197190	198400	
	(corresponds with part of No. 24)			
(53)	aq.$Na_2.Si.O_3$ 2(31234) + 0 + 71515 + 2(96155)	= 326293	326100	
	(corresponds with No. 25)			
(54)	Na.I 32747 + 36226	= 68973	69080	
(55)	aq.Na.I 32747 + 37720	= 70467	70300	
(56)	aq.Na.Cl 32747 + 63870	= 96617	96510	97300
(57)	aq.Na.Br 32747 + 52930	= 85677	85580	85800
(58)	Na.F 32747 + 76820	= 109567	109300 109720	
(59)	aq.Na.F 31234 + 77500	= 108734	108700	
(60)	aq.Na.O.H 31234 + 96155 − 15300	= 112089	111810	
(61)	aq.Na.N.O_3 31234 − 23300 + 3(32341)	= 104957	105670	
(62)	aq.H.N.O_3 − 24350 − 23300 + 3(32341)	= 49373	49090	
(63)	aq.$Na_2.O_2.N_2O_4$ 2(32747) + + 85332	= 215508	215090	
(64)	aq.$Na_2.O.N_2O_5$ 2(32747) + 32341 + 85332	= 183167	182620	
(65)	Na_2.H.As.O_4.aq. 2(31234) − 24350 − 29340 + 32341 + 3(96155)	= 329548	329700	
(66)	Na.H_2.As.O_4.aq. 31234 − 2(24350) − 29340 + 32341 + 3(96155)	= 247400	278700	
(67)	aq.H.Cl − 24350 + 63870	= 39520	39315	
(69)	$H_2.S.O_4.H'_2O$ aq. − 2(24350) + 6217 + 2(32341 + 96155) − 3205	= 211304	210770	T
(70)	aq.H.I − 24350 + 37720	= 13370	13170	T
(71)	aq.H. Br − 24350 + 52930	= 28580	28380	T
(72)	liq. H_2.O 2(24350) + 117460	= 68760	68360 69000	Thomsen Berthelot
(73)	cryst. H_2.O − 2(15300) + 96155	= 65555		

Heat of Neutralisation.

When (60) and (67) produce (56) and (72),

31234 becomes 32747
96155 becomes 117460
− 15300 becomes − 24350

(74) 32747 − 31234 + 117460 − 96155 − 24350 + 15300 = 13768 13780 T

When (60) and (71) produce (57) and (72), exactly the same changes occur, amounting to

(75) 13768 cals. Thomsen's experimental figures are 13750.

When (60) and (70) produce (55) and (72),

(76) the same changes = 13768. 13680 Thomsen

When (60) and (62) produce (61) and (72),

(77) the same changes = 13768. 13680 Thomsen

When twice (60) and (69) produce (48) and three times (72),

2(31234) becomes 2(32747)
2(96155) becomes 2(117460)
2(15300) becomes − 2(24350)
− 3205 becomes 0

(78) 2(1513) + 2(21850) − 2(9050) + 3205 = 30741 32380 Thomsen.

HEAT OF SOLUTION.

When (54) produces (55),

(79) 37720 − 366226 = 1494 1220 Thomsen

TABLE V.

Magnetic Rotation.

			Theor.	Obs. by Perkins
(80)	$NaCl$ 0.97 + 3.932	=	4.902	5.068
(81)	$NaBr$ 0.97 + 7.95	=	8.92	9.19
(82)	NaI 0.97 + 18.32	=	19.29	18.46
(83)	$CdCl_2$ 3.81 + 2(3.932)	=	11.674	11.78
(84)	$CdBr_2$ 3.81 + 2(7.95)	=	19.71	19.7
(85)	CdI_2 3.81 + 2(18.32)	=	40.45	40.8
(86)	$NaCO_2CH_3$ 0.97 + 2.299	=	3.269	3.281
(87)	$NaCO_2C_2H_5$ 0.97 + 2.299 + 1.023	=	4.292	4.308
(88)	$NaCO_2C_3H_7$ 0.97 + 2.299 + 2(1.023)	=	5.315	5.332

where 1.023 is the M.R. of each additional CH_2.

Perkin's results are not entirely experimental since they have been multiplied by molecular weight and divided by S.G. The S.G. of NaCl has been determined by many scientists, and their results vary from 2.011 by *Playfair and Joule*, to 2.26 by Mohs. Kopp's figures are 2.15. 2.17 is the correct value, as shown in No. 11, Table II.

Suppose Perkin employed 2.1. If he had used 2.17 instead his result would have been 4.904, since

$$\frac{5.068 \times 2.1}{2.17} = 4.904$$

This is not by any means the *only* small error that may have been introduced, so that, if Perkin did not actually employ the value 2.1, there is not necessarily any flaw in these remarks. However, it is important in any case to remember that a small difference in the value for S.G. makes an apparently large difference in the final result. Similar remarks apply to all the values obtained by Perkin, given in Table V.

The value 0.97 for *Na corroborates* the volume 11.865, for the law of M.R. is as follows :— The magnetic rotation of an electro-positive element, when in combination, is the product of half its atomic weight and the reciprocal of its relative volume. In this case

$$\frac{23}{2 \times 11.865} = 0.97$$

Since volumes are now being calculated to three or more decimal places, whereas previously they have only been given to two decimal places, a few very small alterations are necessary in some of them.

ROYAL INSTITUTION.

21, Arbermarle Street, London, W.1.

The Christmas Course of Juvenile Lectures at the Royal Institution, will be delivered this year by Professor A. V. Hill, move.v The course will begin on Tuesday, on "Nerves and Muscles; How We Feel and Move." The course will begin on Tuesday 28, at 3 o'clock, when the subject will be "Nerves and the Messages They Carry." The succeeding lectures will be given on December 30: "Muscles, and How They Move"; January 1: "The Heart and some other Muscles"; January 4: "The Lungs and Blood"; January 6: "Nerves and Muscles Working Together"; and January 8: "Speed, Strength and Endurance." The lectures will be fully illustrated by experiments.

SYMPOSIUM ON CHLORINE.

At the 49th General Meeting of the American Electro-chemical Society, held at Chicago, Ill., April 22-24, 1926, a Symposium on Chlorine, under the Chairmanshipof Mr. D. A. Pritchard, Works Manager, Canadian Salt Co., Ltd., Windsor, Ont., featured the technical sessions and aroused great interest.

Several very interesting and important papers were contributed to the Symposium; and, as the manufacture of liquid chlorine, bleaching powder, hydrochloric acid and other chlorine products is carried on in Canada, the subject is of special interest to Canadian chemists. Herewith are presented abstracts of several papers from the Symposium.

Economics of Chlorine.

This paper, by Mr. D. A. Pritchard gave, first, a brief chronological sketch of the Economics of Chlorine, from its inception in 1774 to the present day.

Scheele, in 1774, prepared gaseous chlorine by the action of hydrochloric acid on manganese dioxide. Northmore prepared the first liquid chlorine in 1805. In 1785, Berthollet prepared a bleaching agent, by dissolving gaseous, non-electrolytic chlorine in water, improving the process in 1789, by adding the chlorine to caustic potash solution, at a plant on the Quai de Javelle, Paris—hence the name which it aquired, " Eau de Javelle ". James Watt (inventor of the steam-engine) obtained the process from Berthollet, and handed it on to Charles Tennant, who, after a long study, in 1798 brought out a bleaching solution, by chlorinating milk of lime, and, in 1799, improved the product by chlorinating hydrate of lime, Thus, the bleaching-powder industry was born.

The manufacture of gaseous chlorine by the Berthollet method of heating salt, manganese and sulphuric acid in lead stills continued to be the method of chlorine production until Gossage, in 1836, invented his coke towers, for the condensation of the waste hydrochloric acid gas, evolved in the Le Blanc soda process. This resulted in Scheele's invention of 1774, HCl reacting on MnO_2 becoming the principal commercial method of producing gaseous chlorine.

In 1845, Dunlop invented a process of prepared chlorine by decomposing salt and potassium nitrate with sulphuric acid, giving hydrochloric acid and nitrous oxides as by-products. The chlorine was freed from hydrochloric acid by washing with water, and the nitrous oxides were absorbed by sulphuric acid, and used in the production of sulphuric acid. This process was commercially possible only when linked-up with sulphuric acid manufacture, and, aside from the Tennant Company, was not used to any extent.

In 1885, Dunlop invented a process for Tennant's ,whereby he recovered and regenerated the waste manganese liquors of the Scheele method. In 1868, Deacon and Hurter patented a process of producing chlorine by decomposing hydrochloric acid with oxygen, in the presence of an oxygen carrier. Attempts were made to obtain chlorine from the by-product calcium chloride of the Solvay soda process; and the gradual rise of the Solvay process, the decline of the Le Blanc soda process, and the advent of electrolytic chlorine, have made the Deacon process a matter of history.

The patent of Charles Watt (1851), covering an electrolytic production of chlorine, caustic soda, sodium hypochlorite, etc., is of great historial interest, and was followed by much research in England and Germany. In 1890, the Elektron Company, Griesheim, commenced the first successful commercial manufacturer of electrolytic chlorine. Numerous cell installations were tried out in Europe and in North America, and, at this time, there were no less than fourteen types of cells in use.

Coincident with the changes in the production of gaseous chlorine, the uses of bleaching powder increased, in the textile and pulp and paper fields, and, after 1856, in the coal tar dyestuffs industry in England and Europe. England enjoyed a world-wide market in bleaching powder; and Germany had a large domestic and some export business. The advent of liquid chlorine, however, caused the rapid growth of electrolytic plants in Germany, the United States, and, later, in England, without a corresponding growth in its uses. This condition prevails to-day in Germany, Italy, England and the United States.

The chief concern of the industry to-day is to find new uses for chlorine. The industry cannot make caustic coda, and waste hlorine and hydrogen. There is a large amount of misinformation about the chlorine-alkali industry. It is stated frequently that chlorine is incident to the manufacture of soda and potash. As far as the chlorine industry is concerned they are incident to the manufacture of chlorine. Electrolytic caustic soda is a small percentage of the caustic soda made; and the use of caustic

potash tends to decline, because the cheaper caustic soda replaces it in many operations.

Scientific cell operation requires an expert control, economically feasible only in a central plant, serving a large number of consumers.

Two important considerations are the disposal of the hydrogen and the technique of cell operation. Outlets for hydrogen are synthetic hydrochloric acid, ammonia, alcohols, and the hydrogenation of oils. The manufacture of hydrochloric acid, by combining hydrogen with chlorine gas, was first effected in America by the Roberts Chemical Co., at Niagara Falls, N.Y., in 1902. It is a somewhat hazardous enterprise, on account of explosive risks, but the acid is of a very high purity. Considerable hydrochloric acid is also made by passing chlorine and steam through coke. The real difficulty in the United States and Canada is to dispose of the acid in competition with sulphuric acid. It will readily replace sulphuric, at a price, in numerous operations, including bleaching of cotton textiles and pickling of steel plates, and is used abroad, in large quantities, for such purposes. Abroad, in the pickling of steel plates, ferrous chloride is obtained as a by-product which is, in turn, converted to ferric chloride, furnishing a cheap source of this latter material.

Chlorine cell hydrogen fits admirably into the manufacture of synthetic anhydrous ammonia, and nearly all the hydrogen, not used for other purposes, and now available from this source, at Niagara Falls, is linked up with synthetic ammonia operations. At least one chlorine maker outside of Niagara Falls, is using his hydrogen for synthetic anhydrous ammonia manufacture, and several others are building, or contemplat ing building, small ammonia installations. Synthetic ammonia manufacture, however, will not bring about an increase in chlorine production, in order to secure pure hydrogen; but, to the extent that chlorine cell hydrogen is close to synthetic ammonia operations, it offers a cheap and pure supply to the key to the production of both synthetic ammonia and synthetic alcohols.

A historical and economic survey of bleaching powder is then given. The first Canadian-made bleaching powder was that produced by the Canadian Salt Co., Ltd., Windsor, Ont., in 1912, while the first sold in the United States was made at Rumford Falls, Maine, in 1893. This latter was the first American electrolytic chlorine plant, and used the Le Sueur Cell. Bleaching powder will continue to be made on this continent on a modest scale for years to come, until the traditional uses die out, and all chlorine-users become expert in the application of liquid-chlorine.

Liquid chlorine was produced commercially first in 1888 by the Badische Company, Germany, from which time its manufacture has been highly developed in that country. England had no considerable quantities until after the World War had started. The first Canadian liquid chlorine was made by the Canadian Salt Company, Windsor, in 1922. The first commercial delivery in the United States was in 1909, by the Goldschmidt Detinning Company, Wyandotte, Mich. The business expanded, due largely to the efforts of E. D. Kingsley, of the Electro Bleaching Gas Co., in connection with the bleaching of cotton fabrics and the treatment of potable water supplies. The estimated capacity of all chlorine plants in the United States and Canada, in 1925, was 185,000 tons of chlorine gas—of which 40,000 tons were liquefied.

It is estimated that about 65 per cent. of all chlorine gas manufactured in the United States and Canada is consumed by the paper industry 22 per cent. by the textile industries 10 per cent. in sanitation; and the remaining 3 per cent. in all other uses.

Mr. Pritchard concludes his paper with the statement that a productive capacity, bearing a reasonable relation to consumption, a decent return on its capital, and the continuance of research, are essential to this key industry.

Uses of Chlorine in the Refining of Sugar.

Mr. S. Ochi, of the Tokyo Imperial Industrial Laboratory, Central Hatagaya, Tokyo, Japan, presented a paper, showing the uses of chlorine in sugar refining. It was first proposed to utilise chlorine gas in this connection, about 100 years ago, but the idea was later abandoned.

When chlorine gas is passed into the sugar juice, there results "chlorine water," and the juice contains hydrochloric acid and hypochlorous acid, as the products of hydrolysis of chlorine, as well as free chlorine. The sugar juice or syrup to be treated is subject to the action of these three compounds. Sucrose in the juice has a considerable resistance to the oxidising action of chlorine water, and in such a dilute solution of chlorine as is to be used in sugar-refining, no trace of sucrose is oxidised at all.

Mr. Ochi, however, has demonstrated that the chlorination process for sugar refining is practicable in combination with treatment by activated charcoal. The following has been found experimentally :

The coefficient of the velocity of inversion of sugar in chlorine water is about half the value in hydrochloric acid of equivalent concentration, at the outset of the inversion, and approaches the value of the equivalent hydrochloric acid in the course of the inversion. The presence of molasses retards the velocity of inversion by chlorine water or hydrochloric acid. The bleaching action of chlorine is not very effective in the case of cane juice, but the chlorinated juice can be bleached easily by the subsequent treatment with activated charcoal.

Chlorine has an efficient action in precipitating the suspended matters in cane juice, and this reaction occurs at a pH value of 3.5 to 4.0 for the chlorinated juice. At the same time gums and pectins separate out with the suspended matter. The bleaching action of chlorine on the syrup of raw sugar is effective up to 80 to 90 per cent. of the original colour depth. A bleaching beyond 95 per cent. is almost impossible in a short time. The syrup which contains free chlorine, even one neutralised, turns alkaline, and is coloured dark in the course of the evaporation. The use of activated charcoal subsequent to the chlorination, instead of chlorination only, saves a portion of the chlorine, and a complete bleaching and neutralisation can be obtained.

Use of Chlorine in Organic Chemical Industry.

A very interesting contribution was that of Dr. J. T. Conray, United Alkali Co., Widnes, England, on the Use of Chlorine in the Organic Chemical Industry. The main points in his paper may be cited as follows :—

Chlorine is one of the most widely distributed elements, but never occurs in nature in the free state, nor, so far as the author knows, in any organic compound. Organic compounds containing combined chlorine are mainly the result of developments of the last thirty years, following on the progress made in electrical science and helped by the carbide industry. "Dutch liquid" was discovered in 1795, and chloroform was first produced in 1831, but the important expansion of the chlorine compound industry began in the last decade of the nineteenth century and resulted in a long list of valuable organic chlorine products. The author shows how by the aid of elemental chlorine the aromatic hydrocarbons can be made to yield products which are indispensable intermediates in the economical manufacture of dyes and drugs. The manufacture of mono- and dichlorobenzene, and the control of the proportion of the products, are discussed and lines of research are suggested. The author then goes on to deal with the mono- and the dinitrochloro derivative of benzene, and the corresponding phenols, and with the side chain chlorination products of toluene, benzyl and benzal chlorides, and their oxidation products, benzaldehyde and benzoic acid.

The concluding paragraphs of Dr. Conroy's paper are especially worth repeating here :

"Chlorine is essential to present conditions of life. It is fortunately widely distributed in combined form, and by reason of electrical developments readily produced in elemental condition. It is employed to maintain health and to prevent the spread of sickness. In organic combination, we have in chloroform, one of the earliest known derivatives, a means of minimising pain. By the aid of chlorine in organic combination it is possible to produce other medicinal compounds of great value—the chloroamines, saccharin, etc. We are further enabled by way of chlorine to proceed to the manufacture of artificial silk and of dyes, and so produce products which lead to our pleasure and comfort in life. It is also possible to produce through chlorine other products leading to agony and death; chlorine is an essential of gas warfare.

"Chlorine, like everything else, is capable of 'use and abuse.' Abuse must be controlled; use must be extended.

"In my paper I have endeavoured to indicate the present direction of work, and to show something of what has been accomplished. Other applications of chlorine are known and are in commercial use; further applications of chlorine and its organic derivatives are being investigated, in some cases with considerable promise.

"It has not been possible, nor was it my intention to give a list of all important organic compounds into the manufacture of which chlorine enters. I have further refrained, for reasons which will be appreciated, from entering into a description of plant manufacturing details. My endeavour has been to treat the subject in a general way. Although I may have daded nothing new, I hope that my contribution may

bring home the great importance of chlorine in the organic chemistry to-day and in conjunction with the papers prepared by others may help to suggest fresh possibilities leading to a still further extended use."

—*Canadian Chemistry and Metallurgy.*

THE ABSORPTION LIMIT OF THE K SERIES OF THE ELEMENT OF ATOMIC NUMBER 75.

By MONS. B. POLLAND.

Towards the end of 1925 Dr. Dolejsek and Prof. Heyrovsky published an account of the discovery of the element of atomic number 75. For the present work I have used a preparation obtained by M. Gosman under the direction of Prof. Heyrovsky. It was obtained by slowly precipitating a solution of 1 kg. of $KMnO_4$ with $Ba(NO_3)_2$ solution. Spectroscopic analysis revealed the presence of Mn and Ba together with traces of As, Fe and Pb(but did not show a single line of Zn ,Co, W, Tl, or Hg. The polarographic method indicated the presence of about 1 per cent. of the new element.

Spectrograms taken by Dr. V. Dolejsek had the lines $L\alpha_1$ β_1 β_2 γ_1 of element 75.

I have used this moist, brown, voluminous precipitate to observe the absorption limit of the series for the element. Measurements have been made on a spectrometer constructed by Dr. Dolejsek and the author. This was an ionisation spectrometer with rock-salt crystal carefully adjusted and so turning that the reflected ray always fell on the slit of the ionisation chamber. It was further possible to make measurements from the other side of zero by turning the crystal through 180 degrees.

This enabled Siegbahn's method to be used for precise measurements of the short-wave-lengths. In order to ensure that the crystal actually turned 180°, it was held in position magnetically so as to give a complete refraction.

The sensitivity of the gold leaf electrometer was increased by placing it directly in the ionisation chamber. Its communication with the exterior was only made momentarily on charging, its capacity was thus reduced to a minimum. This arrangement allowed very weak radiations to be measured.

Even with one milli-ampere at a distance of 60-80 cm. from the tube the fall produced on the electrometer could be measured by reflection. The curves obtained were compared with one when no material was interposed. The value are the average of four readings :—

Curve 1	...	0.1733 A
2	...	0.1740
3	...	0.1726
5	...	0.1740
6	...	0.1726
9	...	0.1733
10	...	0.1733

The mean value for the K absorption limit for element 75 is thus 0.1733 A plus or minus 0.0007 A.

To estimate the concentration and to determine the degree of sensitivity of the spectrometer we have also found the absorption limit of Os (At. No. 76). We employed a 1 per cent. solution of osmic acid under the same conditions.

According to Blake, Duane and Schimizu the absorption limit of Os in the K series is 0.1683 A. As the mean of values measured by our method the figure 0.1686 A is obtained, *i.e.*, a value completely in accord with previous results.

On comparing all the curves of the two elements it appears that the first preparation contains about 2 per cent. of 75.

Dr. V. Dolejsek has confirmed all the measurements in this work.

* Translation, slightly abridged, from *Comptes Rendus*, 1926, p. 737.

OBITUARY.

SIR WILLIAM TILDEN.

By the death of Sir William Augustus Tilden on December 11, science loses a remarkable and outstanding figure in the development of chemistry during the last century. He was formerly Professor of Chemistry at Imperial College of Science and Technology at South Kensington. Sir William was perhaps best known as the author of many chemical textbooks and treatises, most of which were so popular that they ran through several editions.

His original investigations were chiefly concerned with organic chemistry and he will be remembered as one who contributed largely to our knowledge of the terpene hydrocarbons and the essential oils. One of his most interesting discoveries was the conversion of the hydrocarbon, isoprene, into synthetic rubber. He must have published hnndreds of original papers in the various scientific journals. Reference to

the General Index of the first hundred volumes of *The Chemical News* shows that contributions of his, which appeared in this journal up to 1909, numbered 47. In addition he was the joint author of about a dozen others. The earliest one, 1865, XI., 220) deals with the periodides of some *organic bases*.

Sir William had many honours bestowed upon him, especially in later life.

General Notes.

WHERE TALCUM POWDER COMES FROM.

Canada possesses one of the most important high-grade talc deposits in the world, according to Dr. M. E. Wilson, of the Geological Survey. This deposit in Hastings County, near Madoo, has been the principal source of talc for the mannfacture of talcum powder in Canada and the United States for a number of years. Formerly all that was not market in Canada was sold in the United States, but since imposition of the Fordney Tariff, considerable quantities are being shipped to the United Kingdom, Germany and other countries. The total production of ground talc from the Madoc properties in 1925 was 13,678 tons valued at $174,116.

RECORD YEAR FOR BRITISH COLUMBIA MINES.

Mr. E. A. Haggen, editor of the *Mining and Engineering Record*, Vancouver, estimates that the mineral production of British Columbia for this year will have a value of approximately $70,000,000, the largest in the history of the province. Last year's figure was $61,492,000. Copper production will be about 95,000,000 pounds, an increase of about 23,000,000 pounds over last year. Silver and lead outputs will each set new records, the former with about 10,000,000 ounces or nearly 50 per cent. above last year, and the latter with about 250,000,000 pounds, compared with about 238,000,000 pounds in 1925. and only 170,000,000 pounds in 1924. The most remarkable feature of recent metallurgical progress has been the recovery of zinc from complex ores which previously defied treatment and the increasing demand for the metal. The output of zinc in British Columbia this year is estimated at 122,000,000 pounds, compared with 98,000,000 pounds last year. Coal alone shows a decrease from last year due to increaser competition of fuel oil.

The Hon. William Sloan, Minister of Mines of British Columbia, goes a step further than Mr. Haggen and, in addition to prophesying that this year's production will show an increase of from $5,000,000 to $10,000,000, *he predicts that in three* years' time the mineral output of the province will reach $100,000,000.

THE COAL MINING INDUSTRY IN CANADA.

According to the final report of the Dominion Bureau of Statistics, Canada's output of coal in 1925 was 13,134,968 short tons, valued at $49,261,951, compared with 13,638,167 short tons, valued at $53,593,988 in the preceding year. The drop in production was largely accounted for by labour troubles in the Maritime producing areas. Alberta's output of 5,869,031 tons placed that province in the premier position among Canada's coal producing areas and marked a gratifying increase over the 5,189,729 tons produced in 1924. British Columbia coal mines produced 2,742,252 tons of bituminous coal compared with 2,193,667 tons in 1924. Nova Scotia mines, in which the output losses were greatest, produced 3,842,978 tons of coal in 1925, as compared with a total of 5,557,441 tons in 1924. New Brunswick and Saskatchewan also contributed to the total production, the former with 208,012 tons of bituminous coal, and the latter with 471,965 tons of lignite.

As in previous years, the United States continne to snpply large quantities of coal to the central provinces of Canada. Imports from that country in 1925 amounted 16,225,603 tons and consisted of anthracite. 3,249,497 tons; bituminous, 12,957,738 tons; and lignite, 18,368 tons. Coal from the United Kingdom and other countries added 606,832 tons, making the total importations in 1925 16,832,425 short tons, a tons imported in 1924.
very slight increase over the 16,828,578

On the other hand exports of Canadian Coal showed an increase over the preceding year, the figures being : 1915, 785,910 tons; 1924, 773,246 tons. Canada ships coal to the western United States and to the New England States. These are the largest foreign markets for Canadian coal, but large shipments also go to Newfoundland and considerable quantities to many other destinations, including United Kingdom, Alaska, the Philippines, Australia, Bermuda, British South Africa and Japan.

THE GOLD INDUSTRY IN CANADA, 1925.

General Review.

Canada's gold mining industry falls naturally into two main divisions: the winning of placer gold, or the "Alluvial Gold Mining Industry," and the recovery of free-milling gold from aurigerous quartz mines, described under the title "The Auriferous Quartz Mining Industry." But in the treatment of ores containing metals other than gold in commercial values, such as copper and silver, gold is often recovered as a by-product; in making up production figures, gold obtained from the treatment of Canadian ores of every kind, is included in the total. Descriptions of these other industries, which do not obtain gold as their main product, are given in other bulletins of this series. In particular, the one entitled "Copper-Gold-Silver Mining Industry" may be mentioned, as most of the other lode mines producing gold in quantity are included in this group.

Historical.

During the early history of the industry in Canada, most of the gold produced was obtained from placer deposits in the province of British Columbia. Later, in 1898, the famous Yukon placers were discovered, and for some time these deposits constituted the principal source of Canada's gold. Recent developments in lode mining, however, have somewhat overshadowed the placer workings; as the placer yields declined, lode gold recoveries increased until now this constitutes the principal source of supply. During the past ten or eleven years the province of Ontaria has come to the front as a gold-producer, through the development of the rich gold quartz mines of the Porcupine and Kirkland Lake districts; the output from British Columbia mines has been improving for several years; new fields, particularly in the Rouyn area in Quebec, are being watched closely as the next gold-producing district.

Sources.

In 1925, the auriferous quartz mines yielded 85 per cent. of the total production; alluvial deposits provided 4 per cent.; Canadian copper and lead smelters recovered 2 per cent.; and gold obtained by foreign smelters in the treatment of Canadian ores of various kinds, amounted to 9 per cent. of the total Dominion production of gold.

Importance of the Industry.

Among Canada's mineral products, gold holds second place in point of value, being surpassed only by coal. In 1925, gold represented 15.8 per cent. of the total value of Canada's mineral output.

Steady progress, too, has been made by Canada as a world producer, and for the past four years, Canada has held third place; the Union of South Africa and the United States continue to hold first and second place, respectively.

South Africa production provides more than half the world's output, while Canada produces more than three-fifths as much as the United States and more than twice as much as Australia or South America, and one and one-half times as much as the continent of Asia.

Ontario.

Ontaria, with its rich mines in the Porcupine and Kirklnad Lake areas, continues to hold the lead among the gold-producing provinces, contributing 84.2 per cent. of the total gold production for Canada in 1925. In the same year Ontario's gold output represented 34.3 per cent. of the aggregate value of the mineral production for the province.

THE DIRECTORATE OF I.C.I. LTD.

The list of directors of Imperial Chemical Industries, Ltd., the new chemical merger, contains many imposing names, but while giving them the credit they rightly deserve, there are a number of men who appear less largely in the public eye, but whose importance to the company could hardly be exaaggerated. They are men of great administrative and technical ability and experience who have already rendered notable service to the companies with which they have been associated. Amongst these is Lieut.-Colonel G. P. Pollitt, D.S.O., a director of Messrs. Brunner Mond & Co., Ltd., the organisers of the manufacture of synthetic ammonia in Britain. Mr. J. G. Nicholson comes from the same firm, and brings with him a world-wide knowledge of sales organisation which he gained from extensive travelling throughout the world.

Mr. B. E. Todhunter, a director of Messrs. Nobel Industries, Ltd., is an engineer of outstanding practical ability, while Mr. H. J. Mitchell and Mr. John Rogers, are technical directors of great experience and achievement.

IMPERIAL COLLEGE, TRINIDAD.

The report of the Principal of the Imperial College of Tropical Agriculture for 1925-26, which has just been published with the prospectus for 1927-28, states that to the diploma course eight students were admitted, bringing the total to 15. To take the post-graduate course qualifying for the associateship, 13 students were admitted, of whom seven were sent by the Empire Cotton Growing Corporation and two by the Colonial Office. One diploma student returned to take the fourth year in sugar technology. Three students took the special one-year course, while three members of the staffs of factories situate in Trinidad attended for a few months.

The associateship has been granted to six students, while two students who attended the college before the terms of the associateship were defined, have been awarded the associateshop. The final diploma examination was attended by three students, of whom all qualified. Two of these qualified in sugar technology and have applier for admission to the fourth year course in that subject. The single student to pass out in general agriculture has secured employment in British Guiana.

PROCEEDINGS AND NOTICES OF SOCIETIES.

THE CHEMICAL SOCIETY.

The following papers were read at the meeting held on December 16 :—

Low-Temperature Oxidation at Charcoal Surfaces. Part III. The Behaviour of Blood Charcoal and the Influence of Temperature on the Reaction Rate. By E. K. Rideal and Miss W. M. Wright.

The nature of the surfaces of blood charcoal has been examined. Only two active areas, one corresponding with the —Fe—C— complex and one with the —C—C— complex of synthetic charcoals were identified.

The area of carbon surface active for the oxidation of oxalic acid varies from 30 to 55 per cent. of the total, depending on the method of preparation of the charcoal. The range of promoter action of one iron atom exteuds to not more than six carbon atoms, and an analogy is sought in the complex iron cyanides. The temperature coefficients of autoxidation and of oxidation of oxalic acid on the various active patches are determined. The variation in adsorption of oxalic acid with the temperature is small; the variation in the temperature coefficient of oxidation with the concentration of oxalic acid follows the anticipated course. The distribution of oxalic acid between the active and inactive areas for various concentrations is determined. From the temperature coefficients the following critical energy increments are calculated : for autoxidation, 11,800 cals. per g-mol.; for oxidation of oxalic acid on the —C—C— complex, 14,020 cals.; on the —Fe—C— complex, 13,030 cals.; and on the Fe—C—N complex, 12,290 cals.

Whilst corresponding surfaces on sugar and blood charcoal are identical in respect to the rates of oxidation of oxalic acid and the temperature coefficients of the rates, yet they differ in the amount of oxalic acid adsorbed per $cm.^2$ at the concentrations of maximum velocity.

On Active Nitrogen. Part II. By E. J. B. Willey and E. K. Rideal.

A study of the admission of gases to the nitrogen afterglow has been made in the light of Klein and Rosseland's hteory of inelastic collisions of the second type. No reaction occurs unless the critical increment of the gas added is less than 55,000 to 60,000 g.-cal. per g.-mol., but is greatest when this is 43,000 and under. It is also possible to induce the combination of hydrogen and chlorine by means of active nitrogen in a manner analogous to the sensitised reactions of hydrogen and oxygen.

These results indicate that the value originally put forward for the energy content of active nitrogent is correct, and that the slight reaction which occurs with substances of higher critcal increments is due to a statistical distribution in the afterglow of three species of active molecules, some just above and others below the mean value obtained calormetrically.

The Dependence of Rotatory Power on Chemical Constitution. Part XXXI. The Resolution of a Sulphilimine into its Optically Active Forms. By G. Clarke, J. Kenyon, and H. Phillips.

From a consideration of the constitution of "chloramine-*T*" from the point of view of the electronic theories of valency it is deduced that the sulphilimines produced by the condensation of that substance with thio-ethers are analogous in constitution to the sulphoxides.

FARADAY SOCIETY.

The following paper was read at the meeting held on October 27, 1926:—

*The Observation of Cataphoresis in Colourless Sols*н *I. The Charge on Rubber in Benzene.* By R. H. Humphry and R. S. Jane.

Introductory.

In the study of colloidal systems in which the dispersion media are non-aqueous it is difficult to make a satisfactory observation of cataphoresis by the methods ordinarily used for aqueous systems. Sols such as those of nickel in benzene and in toluene have been examined by dipping electrodes into the sol itself and obseiving a deposit on the plates, but this method is not above criticism and several hours are iequired for each observation. In a recent note one of the present authors has described a method by means of which a rapid and satisfactory obseivation of the prseence of a charge on the disperse phase may be made in the case of dark coloured sols, such as nickel or silver in benzene, liquid paiaffin, etc. In brief, the method consists of allowing a thin stream of the sol to flow slowly midway between insulated plates in the dispersion medium. When a uniform electric field is maintained between the plates a deflection of the stream occurs which is clearly visible with such dark coloured sols. In the case of some of the nickel sols referred to, a spieading of the streau into a fan shape indicated the presence of both positive and negative charges and confirmed the conclusions of Hatschek and Thorne, who obtained a deposit on each of two electrodes dipping into the nickel sol. If the deflection occurred in one direction only, the presence of the charge was confirmed by reversing the direction of the field.

In the case of colourless or only slightly coloured sols, however, some elaboration is necessary if a similar method is to be employed. The possibility of adding a dye to make the sol clearly visible has been considered, but it is unsafe to assume that such an addition would not influence the charges. Another possibility is the use of the Tyndall effect of scattering, which would occur in the sol but not in the dispersion medium. This method has recently been used by Dumanski and Kniga for aqueous sols with the ordinary U-tube arrangement, but would not be easily applicable in the present case.

The method adopted in the present investigation is to make use of the difference between the refractive indices of the sol and the dispersion medium by applying the Toepler "Schlieren" method. This provides a simple means of observing, with very sharply defined boundaries, the course of a thin stream of a colourless sol (in this case rubber in benzene) flowing in its dispersion medium between two parallel electrodes; the motion of the boundary when the electric field is switched on can be clearly seen.

Observations are made visually (or protogrpahically). After adjustment, as described, the lens is seen faintly illuminated, in some parts more intensely than in others; this is due to imperfections in the lens, which is of short focal length, but does not inteifeie with the observations. The choice of a lens of short focal length is an advantage in that it permits the whole apparatus to be set up on an ordinary bench, the overall length being about 8 feet in the present case. It appears to make little differenee to the observations, although, as usually employed, the Toepler method requires a good achromatic lens combination of long focal length.

The sol is allowed to flow slowly in a downward stream between the electrodes, which aie kept at the same potential and its couise is seen as a thin bright band. Owing to the very slight difference between the densities of the sol and the dispersion medium a downward course is ensured by slight cooling of the sol. A known difference of potential is then applied to the electiodes by means of a potential divided on the lighting mains (200 volts) and the subsequent movement of the sol is noted. A reversing key is included in the circuit. The potential differences applied were 68 volts with the plates 1 cm. apart and 200 volts with the plates 1.5 cm. apait, giving fields of 68 and 133 volt/cm. respectively.

Preparation of the Sols.

One of the difficulties encountered in investigations of non-aqueous sols is the presence of water in either or both phases. In considering the motion of the sol in an electric field it is necessary to preclude the possibility of electrostatic effects arising from the presence of a mass of liquid of of greater (or less) dielectric constant than the surrounding medium. It was for this reason that a dispersion medium and a disperse phase with nearly equal dielectric constants were chosen. The dielectric constant of rubber is about 2.2 and that of

259,631. Butyl alcohol; acetone. Desborough, A. P. H., Thaysen, A. C., and Green, B. M., Royal Naval Cordite Factory, Holton Heath.

Niccoli, E.—Process for producing pure potassium salts.

Abstract Published.

Fusel oils.—In a fermentation process for the production of *n*-butyl alcohol and acetone from erusalem artichokes, the fermentation is carried out in a mash, of 20-30 per cent. strength, formed by diluting a 50 per cent. mash after hydrolisis of the carbohydrates therein, as by boiling with 0.2 per cent. of sulphuric acid.

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TORBRONS.

474,364.—Chemical substances prepared for use in medicine and pharmacy.—James William Torr, 26, Tyrrel Street, Bradford. December 8th. Patent 208516.

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THE NITROGEN FIXATION INDUSTRY AND OUR FUTURE FOOD SUPPLIES.

By DR. F. A. FREETH, F.R.S.

The great industrial expansion and increase of population in the last century in this country soon reached a point where food requirements were greater than home supplies. From that day to this we have imported large and increasing quantities of essential food stuffs. Such supplies were drawn from the great open fertile spaces of the world. The wonderful virgin plains of Canada and the United States to mention one tract only, yielded splendid harvests year after year without the addition of artificial fertilisers. Agriculture in such districts was living on the accumulated resources of centuries. The situation in this country, however, has been quite different for many years. It is true that a plot of ground will go on yielding a wheat crop of a sort without addition of manure of any kind. There is such a one at the Rothamstead Agricultural Station, but the yield per acre soon falls below an economic limit.

Nitrogen in a chemically combined form is one of the essentials of plant life. Nitrogen constitutes about four-fifths of the air we breathe, but in the air it is in its native elemental condition and such is practically useless for agriculture. There are in the soil certain bacteria which are capable of assimilating and combining nitrogen direct, but the quantity which they can thus 'fix' falls greatly short of that required under modern agricultural conditions. Nitrogen is an inert material and does not combine readily under easily obtainable conditions.

It is usually added to the soil in the form of a combination with oxygen or with hydrogen. Up to fairly recent years the principal sources of supply of fixed nitrogen have been the great Chile nitrate fields, the product of which, sodium nitrate may be classified as an oxygen compound of nitrogen, whilst the other, the familiar sulphate of ammonia, which can be regarded as a hydrogen compound of nitrogen has been derived as a bye-product from the distillation of coal.

Now, since water is composed of hydrogen and oxygen, and the air of nitrogen and oxygen, it will be seen that the raw materials for the fixation of nitrogen are, at least in part, common to the whole of mankind. It has already been mentioned that for many years we have been living on the stored up agricultural resources of the world. Whilst these are far from being

exhausted their call for ouside assistance in the form of fixed nitrogen is definitely increasing; today it is consderable, in the near future is will be enormous. It is, for example, open to grave doubt if the Chile nitrate fields and the gas works industry could between them supply the present nitrogen requirements of the world.

The rise of the synthetic nitrogen industry is one the greatest chemical changes of modern times, and is one of the utmost importance for the future of our food supplies. As this article makes no pretence to be exhaustive and only deals with main tendencies, it is possible to give only a broad summary of the industry.

It has already been mentioned that nitrogen is required, combined either with hydrogen or oxygen; in either case the resultant material requires another substance to, as it were, solidify it and hold it down. The product of the combination of nitrogen and oxygen is an acid, nitric acid, which must be neutralised by an alkali, usually lime, before it can be used in agriculture, whilst the combination of nitrogen with hydrogen is an alkaline gas (ammonia) which must be neutralised with an acid, usually sulphuric acid. From the point of view of Great Britain it is impracticable to combine nitrogen with oxygen. In countries where the abundance of waterfalls furnishes very cheap electric power it is possible to burn the air itself by means of an electric flame forming nitric acid. This process is impraticable in Great Britain, and we have therefore to fall back on the combination of nitrogen and hydrogen, or as the ancients would have put it, air and water. Here, again, by reason of our lack of water power an attractive possibility is ruled out. It is well known that by passing an electric current through water it is decomposed into hydrogen and oxygen gases, which appear separately at the places which the electricity enters and leaves the water. This process is dependent on cheaper power than we can produce in this country. As far as we are concerned, the problem is solved by our great national asset of coal.

A process has recently been developed on a great scale in the North of England, at Billingham, County Durham, at the works of the Synthetic Ammonia and Nitrates, Ltd., a constituent of Imperial Chemical Industries Ltd., which is already tending to, and will eventually, render us independent of foreign supplies. The raw materials are water, air and coke. It may be described in a simple manner by saying that coke is burnt, burning being in combination with oxygen, in a mixture of air and steam in such a way that the coke robs both the air and the steam of their oxygen and leaves a mixture of nitrogen, hydrogen, and the combustion product of coke, namely, carbon dioxide. The carbon dioxide is removed with little difficulty, leaving a mixture of nitrogen and hydrogen which are the constituents of ammonia. These are then brought to a very high pressure and passed over a catalyst. A catalyst is a material which promotes, but takes no part in a chemical reaction and can be used over and over again. They combine and form ammonia gas, which has to be reduced to a form which will render it usable and transportable. This is done by means of the above mentioned carbon dioxide, which combining with amonia to form ammonium carbonate, acts by double decomposition, on calcium sulphate, a material which this country possesses in very great quantities. Ammonium carbonate and calcium sulphate yield ammonium sulphate, the chemical name for sulphate of ammonia, and calcium carbonate. The sulphate of ammonia, produced as outlined above, is a first-class agricultural manure. It can only be profitably made in enormous units with very high output, and it may be predicted that the future nitrogen supplies of the world will be prduced at quite a limited number of places, one, and not the least important of which, will be in this country.

There is a very interesting connection between the fixation of nitrogen and the supply of explosives in war time. This country in the Great War derived the whole of its fixed nitrogen supplies from Chile. Germany did not go to war until she was assured that her nitrogen fixation industry was sufficiently developed to supply her requirements, as she could not hope to keep open the long sea route to Chile. It is now common knowledge that both the Allied and Enemy General Staffs under-estimated their requirements in the early stages of the war and that Germany was compelled to and did expand her synthetic production enormously.

Explosives for war purposes may be roughly classified into propellants such as cordite, and explosives proper, such as T.N.T. and ammonium nitrate. All these materials which modern warfare consumes literally in thousands of tons, require nitric acid for their manufacture. It has just been

stated that the great newly-established British nitrogen fixation industry produces ammonia. Ammonia when burnt with a a limited supply of air yields nitric acid. It will thus be seen that both for peace and war the new development is of the greatest national importance.

A NEW CONDENSATION PHENOMENON.

By F. H. Loring.

It was Crookes who contributed so largely to the early work on cathode-rays with vacuum tubes, and when X-rays were discovered by Röntgen, X-ray tubes were frequently spoken of as *Crookes' tubes*. It is not necessary here to trace back the history of cathode-rays which excite X-rays, but the names of Plücker, Hittorf, Goldstein, Crookes, Puluj, Hertz, Lenard, Röntgen, Perrin, J. J. Thomson and Wehnelt, were leading early contributors in this field of research.

Dr. W. D. Coolidge, of the General Electric Company, of the United States, had already given us a very perfect and powerful X-ray tube, based in general on the early discoveries and developments, as many types of tubes had made their appearance; but the distinguishing feature was the production of electrons by using a hot-wire cathode usually of tungsten, all of which is almost too well-known to need mentioning here. Quite recently Coolidge has perfected a newer type of tube whereby the cathode-rays are brought well out into the open, the tube being still a high vacuum tube, as before, with an electrically heated tungsten wire which emits electrons copiously. Tubes of this type are sealed off from the pump so that they become very portable tools.

In this tube the cathode-rays are passed through a very thin metal window, as was done by Lenard many years ago. It is well-known that aluminium-foil windows are in common use for the passage of X-rays in spectra work. The tube has, however, undergone many profound modifications in the hands of Dr. Coolidge.

In this new tube very thin nickel foil forming the window is supported against the air pressure from outside by a molybdenum honeycomb grid. In short, the design and operation is now such as to give very powerful cathode rays and some X-ray radiations in air, these rays and radiations extending two feet from the window.

Various materials have been subjected to this powerful fusillade of electrons (cathode-rays) together with some radiation proper, *i.e.*, X-rays, as the cathode-rays produce the Röntgen radiation when they strike atoms.

In one experiment, that is of interest here, acetylene gas is condensed into a fluffy, yellow powder, apparently inert, since no chemicals have yet been found which will dissolve it. This substance may be formed directly on surfaces as an inert film. This is of interest in connection with the present writer's experiments and proposed condensation scheme (see this Journal, May 14, 1926, p. 311; December 3 and 17, 1926, pp. 356 and 387), which latter if applied to the atoms composing acetylene (C_2H_2) gives a suggestive result, thus:—

Elements	Masses or At. Wts.	Atomic Nos.
Carbon	12	6
Carbon	12	6
Hydrogen	1	1
Hydrogen	1	1
Inert substance ...	26	14 − 4 = 10

It will be seen that 10 is the atomic number of inert neon and the mass, 26, is not very far removed from the two isotopes of neon of masses 20 and 22. Some of the higher members of the inert group have as many as seven isotopes. Of course, this schematic treatment is perhaps a chance coincidence, at least in so far as the parallel in inertness is concerned. More information about this inert substance is desired and further experiments are necessary.

DEVELOPMENTS IN STEAM POWER PRACTICE.

Remarkable Thermal Efficiencies Now Being Obtained.

By A Well-Known Engineer.

It has before been remarked that steam power plant practice is rapidly becoming a branch of chemical engineering, with the adoption of most scientific methods of design and control. This is well borne out by the proceedings of the recent Congress of the American Institution of Electrical Engineers in which it was emphasised that the outstanding features of the past 12 months are undoubtedly re-heating of the steam between the stages of the turbine, the use of bleeder steam for feed-water

heating, air heating, and the burning of pulverised coal. In large power station practice we have now arrived at 4-stage bleeder heating in the case of very high pressure steam, 500 lbs. and over, but the limit has apparently been reached in this connection, while considerable difference of opinion still exists with regard to the real nett value of re-heating the steam between stages of the turbine, which is thermally efficient but involves considerable capital cost, extra attention, and other complications.

Some very interesting data was given concerning the present performance of different types of power station, and for example in one case with 4-stage bleeding and air heating, I.K.W. is being obtained for 13,360 B.Th.U., while in another instance with 3-stage bleeding and air heating, together with feed-water economisers, the figure is 13,030 B.Th.U., an amazing figure, very nearly half that of most power stations where the thermal efficiency from the raw coal to the switchboard does not exceed about 15 per cent.

With regard to steam generation air heating is now making more rapid strides than ever in the United States, and the whole of this development arises from the original installation of two experimental " Usco " air heaters at the Colfax Power Station, Pittsburgh, in 1922. These achieved a notable success with mechanical stokers, as shown by the well-known papers given by C. W. E. Clarke, before the American Institution of Mechanical Engineers, while the principle is now also proved to be a highly efficient proposition with pulverised fuel firing. In fact the heat obtained in the furnace is so intense that modern water-cooled walls, such as the " Murray-Usco " would have been rendered necessary, quite apart from thermal efficiency considerations. Many different modifications are, of course, possible, according to the conditions, in a large number of cases, for example, the air on its way to the air heater being first passed through hollow fire-brick walls if these are situated at the front and back. Economisers are not being used to the same extent in American power stations, but the feed-water at a temperature up to 350° F., because of multi-stage bleeeding, is passed direct to the "Murray" or other water-cooled walls, consisting as is well-known, of 4-inch vertical steel tubes under full boiler pressure, resulting in a remarkable high rate of radiant heat absorption.

General Notes.

INTERNATIONAL COMBUSTION LIMITED.

This company announces the receipt of a number of contracts from various parts of the world, one being from the Broken Hill Proprietary Company, Australia.

LEAD AND ZINC IN CANADA.

The amount of both lead and zinc produced in Canada during the past year has again increased over that of the previous year. During the half-year period ending June 30, 1926, the zinc produced amounted to 67,159,570 pounds, as compared with 55,257,772 of the corresponding six months of 1925, while that of lead during the same period of 1926 was 138,397,755 pounds as compared with 128,398,836 produced from January to June, inclusive, in 1925. Of both of these metals, over ninety per cent. is produced in British Columbia and most of this in turn comes from the Sullivan Mine at Kimberley, owned and operated by the Consolidated Mining and Smelting Company at Trail, B.C. The Sullivan concentrator is treating at present three thousand tons of zinc and lead ore per day and its capacity is being increased to four thousand tons per day.

ONTARIO GOVERNMENT TO AID SEARCH FOR OIL AND COAL.

The Natural Resources Intelligence Service at Ottawa reports that according to an announcement by Premier Ferguson, the Government of Ontario is planning a campaign of exploration of the oil and coal possibilities of Northern Ontario. Details are being worked out by the Mines Department. It is understood that the Government will assist responsible operators who make approved plans for diamond drillling or shaft sinking to the bituminous beds which some think underlie the lignite coal deposits so plentifully scattered throughout the country between James Bay and the Transcontinental line of Canadian National Railways.

The oil chances of the country have, under recent investigation, been found to be promising and examination by experts has revealed hope that Northern Ontario can be made an oil producing country.

SALT.

There was an appreciable increase in Canadian shipments of salt during the first

half of 1926; the total sales during this period were reported at 124,921 tons valued at $708,664. During the corresponding period of last year sales amounted to 105,770 tons at $650,965.

The Ontario production was 120,524 tons; Nova Scotia 3,641 tons; and Alberta 756 tons. The Alberta shipment was made from the Fort McMurray district.

BOARD OF TRADE ANNOUNCEMENT.

Safeguarding of Key Industries.

The Board of Trade give notice that representations have been made to them under Section 10 (5) of the Finance Act, 1926, regarding the following articles :—

Acetone; Furfurol; Nickel Hydroxide; Piperazine Citrate.

Section 10 (5) of the Finance Act, 1926, is as follows :—

"The Treasury may by order exempt from the duty imposed by section one of the Safeguarding of Industries Act, 1921, as amended by this Act, for such period as may be specified in the order, any article in respect of which the Board of Trade are satisfied on a representation made by a consumer of that article that the article is not made in any part of His Majesty's Dominions in quantities which are substantial having regard to the consumption of that article for the time being in the United Kingdom, and that there is no reasonable probability that the article will within a reasonable period be made in His Majesty's Dominions in such substantial quantities."

Any person desiriug to communicate with the Board of Trade with respect to the above-mentioned applications should do so by letter addressed to the Principal Assistant Secretary, Industries and Maunfactures Department, Board of Trade, Great George Street, S.W.1., within two months from the date of this notice.

15 December, 1926.

COAL OUTPUT.

For the week ending 27 November, 455,034 miners were at work in Great Britain and produced 2,824,000 tons of coal.

PROCEEDINGS AND NOTICES OF SOCIETIES.

ROYAL SOCIETY OF ARTS.

Cantor Lectures.

(Extract from Lecture I.—Delivered March 15, 1926.)

THERMOMETRY.

By W. F. Higgins, M.Sc.

In dealing with the subject of thermometry it may be of interest to give some consideration to the historical aspect in order to trace the evolution of the thermometer from the early types to the modern instrument. It is somewhat surprising to note that, prior to the later part of the 16th century, no attempts appear to have been made to measure temperature, although the sensations of heat and cold must have been apparent iu the earliest days of civilisation. Excavations of Roman houses show that elaborate precision was made for heating the rooms and baths, but there does not appear to be any record of temperature measurements having been made in those days.

The earliest instruments employed for the measurement of temperature can scarcely be called thermometers, but might more aptly be termed thermoscopes, and references to these instruments appear early in the 17th century from which it may be inferred that the invention of the thermometer dates back to about 1600. The invention has been credited by the early writers to a number of contemporary scientists, among whom may be mentioned Drebbel, Galileo, Sirpi, Fludd, and Sanctorius. Drebbel is given on the authority of D'Alence, the writer of a treatise on "Barometers, Thermometers and Hygrometers," published anonymously in 1688, and the date given for the invention is 1608. This name and date have been copied by the Abbé Nollet and many other writers. Viviani, in his life of Galileo, written in 1718, however, attributes the invention to Galileo in about the year 1592, and from ocrrespondence between Galileo and Sagredo and other scientists of his time, it would appear that he used thermometers prior to the date ascribed by D'Alence to Drebbel's invention. It is accordingly probable that the thermometer was invented by Galileo between 1590 and 1600. The earliest type of instrument consisted of an inverted flask

with a long neck, the end of which dipped below the surafce of a liquid contained in an auxiliary vessel. On warming the flask some of the contained air was expelled, and on subsequent cooling and contraction of the air, the liquid rose in the neck of the flask. Changes of temperature were then made manifest by changes in the level of the liquid as the air expanded and contracted. The instrument so constructed may be termed an air thermoscope and its indications are influenced by changes in the barometric pressure as well as by changes of temperature. The next step forward was the employment of the expansion of a liquid instead of a gas, and instruments of this style are mentioned in the Proceedings of the Florentine Academy of Science. It is to Ferdinand II., Grand Duke of Tuscany, that the direct forerunner of the thermometer as we know it is ascribed, as, about 1650, he introduced the marked improvement of hermetically sealing the upper end of the thermometer tube. The thermometers of the Florentine Academy were also provided with scales of degrees. These scales were, however, very arbitrary, and it was not until later that definate methods of standardisation were introduced. Boyle, in 1665, calls attention to the desirability of a standard method of graduating thermometers, and states that the ferezing point of distilled water has been suggested as a standard of coldness. In his book " On Experiments Touching Cold," Boyle points out the advantage of the sealed type of thermometer, the Florentine weather-glass as he calls it, over the earlier forms which were susceptible to changes of barometric pressure. He also calls attention to the inaccuracy resulting from the lack of uniformity in the thermometer tube, and further suggests the freezing point of oil of aniseed as a suitable temperature for starting the graduation of a thermometer, and that the degrees of the scale should be reckoned as definite increments of expansion of the filling medium. Boyle did not, however, carry this beyond the stage of suggestion. Hooke, about the same time, also put forward a suggestion that the freezing point of water should be used for starting the graduation of the scale. Dr. Halley again raised the desirability of standardising the scales of thermometers, but, thinking that the freezing points of liquids were not constant, suggested that the temperature of an underground cellar should be taken as the starting point for the divisions. His reason for this suggestion is apparently that Boyle had found that the level of the spirit in a thermometer remained constant during the winter and summer at the end of a tunnel cut in the face of a cliff some 80 ft. below the level of the ground and 130 ft. from the front of the cliff. This uniformity of temperature of an underground chamber was confirmed by observations made by Marriotte and de la Hire in the cellars of the Paris Observatory.

Sir Isaac Newton constructed a thermometer filled with linseed oil and adopted a definite scheme of graduation. He measured the expansion of the oil in his thermometer and marked off his scale proportionately to the expansion; calling the freezing point of water 0° and the temperature of the body 12°. He found that water boiled violently at 34°, tin melted at 72°, and lead at 96°. He also made his celebrated experiments on the rate of cooling of heated bodies and correlated the results with his scale of temperatures. His scale was published in the Philosophical Transactions of the Royal Society in 1701.

It might me bentioned here that the use of linseed oil as a thermometric liquid enables the thermometer to be used above the boiling point of water, and this instrument may in consequence be considered as the precursor of the high range thermometer.

Passing over the work of Amontons and de la Hire, the next stage in the development of the thermometer is due to the work of Fahrenheit, whose scale (slightly modified) survives to the present day.

Fahrenheit used three points in defining his scale, namely, the temperature of a mixture of ice, water, and sal ammoniac or salt, the temperature of the normal healthy body. The numbers assigned to these temperatures were 0, 32 and 96 respectively. It is probable that in the first instance the number 96 was originally taken as 12, the same as the number of inches to the foot, but owing to the resulting degrees being inconveniently large, the figure 96, a multiple of 12, was chosen as being more useful. The boiling point of water was found by him to 212 on this scale, but it should be emphasised that this temperature was not taken by Fahrenheit as a fixed point. Later when the two points, the temperature of melting ice and of boiling water, were generally adopted as fixed points, Fahrenheit's numbers 32 and 212 were retained, with the result that his original point 96

became nearer 98. Fahrenheit was also one of the first workers definitely to employ mercury as a thermometric liquid, although the use of this had been suggested earlier, and probably instruments had been constructed with it. He pointed out that mercury could be used up to 600° on this scale, but that above this the mercury begins to boil. He also made some of his instruments with cylindrical bulbs instead of spherical, so that the sensitiveness should be increased by the larger surface. Fahrenheit's work dates from 1720 to 1726.

The work of Réamur about 1730 deserves mention as his scale surives to the present day to a limited extent on the Continent. Réaumur employed spirit thermometers and took the melting point of ice as his one fixed point. The value of a degree was then obtained by assuming that the volume of spirit was 1000 parts at 0°, and that each successive expansion of one part corresponded to a rise of temperature of one degree. On this basis he found the value of the temperature of boiling water to be 80 degrees. He, however, overlooked the fact, as pointed out by Martine, to whom we shall refer again later, that a spirit thermometer cannot be employed up to such a high temperature. Réaumur's figure 80 is taken as the boiling point of water on the scale now bearing his name, but in view of the above remarks it is obvious that the scale originally employed by him and the present-day Réaumur scale are not identical.

The origin of the Centigrade scale of temperature is the next point of interest. The acceptance of the melting point of ice and the boiling point of water as the two fixed points and the division of the temperature interval between these two points into 100 equal parts is due to the suggestion of Celsius of Upsala in 1742, but it is of importance to note that Celsius himself denoted the freezing point by 100 and the boiling point by 0. Inversion of this procedure was proposed by Stormer, a colleague of Celsius, a few years later, while the suggestion had also been put forward independently by Christin of Lyons in 1743.

Before completing the historical résumé of the subject reference should be made to the publication in 1792 of a book by Dr. Martine entitled "Essays on the Construction and Graduation of Thermometers and on the Heating and Cooling of Bodies." Dr. Martine discusses in some considerable detail the discovery and early history of the thermometer and gives a chart comparing the numerous scales which had been proposed from time to time. He also calls attention to the following points: –

(a) The variation of the boiling point of water with changes of barometric pressure.

(b) The calibration of a thermometer tube by means of a detached thread of mercury.

(c) The difference in scales resulting from different kinds of glass.

(d) The disadvantages attached to the use of a liquid which wets the glass tube, particularly if the liquid in question is very viscous.

(e) The sluggishness of the thermometers provided with large bulbs, and he advocates the use of a small bulb combined with a fine capillary to secure a reasonably open scale.

Martine does not, however, refer to the scale of Celsius, although this had been proposed fifty years earlier than the publication of his essays, and it would appear that the Fahrenheit scale was so very firmly established in this country at his time that other scales were not given much attention. Martine's book gives us a very clear idea of the position of thermometry at the end of the 18th century, and by this time it may be said the subject had been put on a fairly satisfactory basis and that later developments concern themselves chiefly with matters of detail. Increase of precision in determination of temperature was called for, as progress in all branches of science demanded increased accuracy of measurement. Further, the provision of greater facilities for improved workmanship, and a widening knowledge of the properties of materials, has reacted beneficially on the science of temperature measurement.

The majority of the thermometers referred to in the historical survey were spirit thermometers, but the use of mercury as a thermometric liquid has been mentioned. Fahrenheit was one of the earliest workers who employed mercury to any large extent, and it may be of use to consider what advantages mercury has to offer for the construction of thermometers. On examination of the matter it will be seen that these advantages are numerous. Firstly, mercury exists in a liquid state over a wide range of temperatures. Its freezing point is about −38° C., while its boiling point is about 356° C. under normal pressure. It is liquid over a very large proportion of the range of temperatures which obtain under ordinary conditions, not only for those occurring naturally but for a large part of the range over which scientific and

commercial processes are carried out. At the lower end of the scale we occasionally find that in cold climates temperatures below −40° C. are met with and mercury thermometers cease to function. At the upper end of the scale the working range of a mercury thermometer can be very largely extended by reason of the increase of the boiling point of mercury under pressure. The boiling point of mercury under normal atmospheric pressure is about 356° C., but by increasing the pressure of the gas above the mercury column in a thermometer tube the boiling point may be increased to such an extent that temperatures as high as 550° C. to 600° may be measured by means of a mercury thermometer. Secondly, the expansion of mercury is regular, that is to say, mercury does not exhibit any such anomaly as is shown by water, which has a maximum density in the neighbourhood of 4° C. If we employed a thermometer in which water was nsed as the thermometric fluid, the position of the column at any temperature between 0° and 4° would also correspond to a temperature between 4° and 8° C., and the readings over this range would be ambiguous. The expansion of mercury, however, is not exactly proportional to the absolute temperature, so that the normal scale of a mercury thermometer is subject to a small correction to convert the readings to true temperatures.

Again, mercury does not " wet " glass, so that it may be used in a fine bore tube without being held up in the tube by capillary action. This may be considered in the nature of a compensation to one disadvantage which mercury may be said to possess. In comparison with many other liquids its coefficient of expansion is comparatively small, so that in order to obtain a reasonably open scale without unduly increasing the size of the bulb very fine bore tubing must be employed for the stem of the thermometer. This is, of course, one of the main reasons that mercury did not find favour with early workers, as in those days uniform tubing of fine bore was no doubt very difficult or even impossible to obtain. Associated with the use of mercury in fine tubes, it may also be noted that mercury is opaque, so that it can readily be seen in such tubes in which a transparent liquid would be very troublesome to detect. Another minor advantage is the readiness with which mercury can be obtained in a high state of purity by distillation.

ROYAL INSTITUTION OF GREAT BRITAIN.

Abstract of Christmas Lectures By Professor A. V. Hill, M.A., Sc.D., F.R.S.

Adapted to Juveniles.

Nerves and the Messages They Carry.

Tuesday, December 28, 1926.

Nerves are long thin living threads which —like the wires of a telephone system— carry messages between different parts of the body. These messages are waves of something electrical—they can be started off by an electric shock, and recorded by electrical instruments. They travel faster than an aeroplane; they tell us what is happening outside (or inside) us; they take orders to our muscles. All that we feel, pain, touch, heat ,cold, taste, smell, light, sound, is due to streams of such nervewaves, started by tiny " microphones " dotted over the body. And our replies to these messages, the orders we send to our muscles, are also streams of waves, starting out from the nervous system which lives—well protected —inside our skulls and backbones.

Thursday, December 30, 1926.

Muscles and How They Move.

A muscle is a mass of thousands of thin jelly-like living threads, each able to shorten—or stiffen—when excited by a message from its nerve. It pulls on the bones, and so moves, or holds, a limb. We know a lot about muscles, chiefly because they can be taken out from an animal and experimented with. They may live for days and weeks after their previous owner is dead; they can be made to work by an electric shock; they can be tired out, aud allowed to recover; they produce heat —like any machine; they use up sugar and oxygen; they give out electric currents. They are enormously strong, in spite of their jelly-like nature. In some animals they are amazingly quick; in man they are not very quick; he is too big, and if he moved too quickly he would break.

Saturday, January 1 ,1927.

The Heart and Some Other Muscles.

There are other kinds of muscles, as well as those which move our limbs. Of these the most beautiful and important is the heart. Its duty is to pump blood round the body, and in doing so it performs an enormous amount of work; and it may give three thousand million beats, or more, before it stops. It is easy to experiment with the heart, either by killing an animal

and taking it out, when it will go on beating for hours and days, or by examining it in men. Your heart can be photographed by X-rays; its electric currents can be registered; its beat can be seen, or, felt, or heard.

Of other muscles there are those which work the apparatus with which we digest our food; those which open and close our blood vessels; those which do various little jobs like standing our hairs on end; those which close the pupils of our eyes; but they all work in the same kind of way.

Tuesday, January 4, 1927.

THE LUNGS AND THE BLOOD: HOW THE MUSCLES GET AIR AND FUEL.

Muscles, like motors, need fuel and air. Oxygen from the air is taken by the lungs into the blood, which carries it to the muscles. The fuel which the muscles use is sugar; they keep a good store of it ready, which they replenish from the blood as needed. When a muscle begins to work its blood vessels open at once; the heart beats more quickly, and breathing becomes deeper and more rapid. If the exercise is very hard, and the muscles cannot get enough oxygen, they get tired; they become acid and stiff and have to stop. They need a rest, during which they go on using oxygen and sugar, until they are quite fresh again. This recovery business takes rather a long time, at any rate after hard work.

To walk a mile at an ordinary pace needs about half an ounce of sugar, and less than three gallons of oxygen; the same is wanted for running 200 yards "all out." Asleep in bed this would last nearly an hour. Such experiments are easy to make on men, and by making them we have learnt a lot about muscular exercise.

Thursday, January 6, 1927.

NERVES AND MUSCLES WORKING TOGETHER.

Many of our movements are automatic or "reflex"; we blink when we see a flash, jump when we hear a bang; we right outselves when we slip or fall; we betray our emotions in various ways (the most stubborn of us cannot hide them from certain quite ordinary electrical instruments). A frog whose head has been cut off will scratch things from his back. Such "reflexes" and the means by which they are brought about, are a most important part of our life. The accuracy and speed with which we move, the ease with which we judge distances, times and directions, are astonishing. The cat has only one fifth of a second to carry out all the complicated movements needed to make him fall on his feet when dropped; in throwing a stone, in hitting a ball, in jumping, we are showing the most amazing skill in timing and adjusting our movements properly; and all these things depend upon the continual passage of *millions of messages to and fro along our* nerves, telling us where everything is, and giving orders to our muscles.

Saturday, January 8, 1927.

SPEED, STRENGTH AND ENDURANCE.

The speed at which we can do a job of work—or run a race—depends upon several things. It is greater if our muscles are strong, if we are skilled in using them, if we have endurance—the power of going on long. It is tiring and wasteful to go too fast, or to go too slow; there is a "best speed." It is possible to-day to *measure* some of these things; and science begins with measurement. Skill is greater the less the amount of oxygen—and food—required to finish a given task. Strength can be measured by the greatest possible output of energy in a short time. Endurance depends upon the efficiency of heart and lungs in supplying us with the oxygen we need. Success in such sports as running and mountain climbing depends—apart from moral qualities—largely on things like these; some day we may even be able to select our prospective champions with something like scientific certainty.

THE CHEMICAL SOCIETY.

At the ordinary scientific meeting of the Chemical Society held on December 16, 1926, the President, Professor H. Brereton Baker, C.B.E., D.Sc., F.R.S., announced that the Council had unanimously resolved to award the Longstaff Medal for 1927 to Professor Robert Robinson, F.R.S., of Manchester University, for his distinguished researches in Organic Chemistry.

It was also announced that in accordance with the terms of the Trust Deed establishing the Edward Frank Harrison Memorial Prize, the Selection Committee, consisting of the Presidents of the Chemical Society, the Institute of Chemistry, the Society of Chemical Industry, and the Pharmaceutical Society, had met to consider applications for the Harrison Memorial Prize which shall be awarded to the chemist of either sex being a natural born British subject and not over thirty years of age who in the opinion of the Selection Committee shall during the past five years have conducted the most meritorious and promising original investi-

gations in Chemistry and published the results of those investigations in a scientific periodical or periodical. The Selection Committee has unanimously resolved that the prize for 1926 of the value of £150 should be awarded to Dr. Charles Robert Harington, of the University College, London.

Dr. Harington has within the last five years synthesised the active principle of the thyroid gland (thyroxine); he has determined its constitution and worked out a practical process by which it may be produced on a large scale. This artificial product has been found to have the same physiological efficacy as the active principle in the natural extract.

The presentation of the Longstaff Medal and of the Harrison Memorial Prize will take place at the Annual General Meeting of the Chemical Society on March 24, 1927.

KAMERLINGH ONNES MEMORIAL LECTURE.

The Kamerlingh Onnes Memorial Lecture will be delivered by Professor Ernst Cohen, of Utrecht, at the Institution of Mechanical Engineers, Storey's Gate, S.W.1., on Thursday, February 10, 1927, at 8 p.m.

GEOLOGICAL SOCIETY OF LONDON.

December 1, 1926.

On Lower Old Red Sandstone Plants Showing Structure, from Brecon (South Wales.) By DR. ALBERT HEARD, M.Sc., F.G.S.

A new fossil plant-locality is recorded from the Senni Beds, in the neighbourhood of Brecon. Several genera of a Lower Old Red Sandstone flora have been obtained from this occurrence.

A new method of ascertaining details of the internal morphology of pyritized plant-specimens is described.

A new Lower Old Red Sandstone plant, *Gosslingia breconensis*, is recorded; the plant is rootless and leafless, with stomata and hairs. Gregarious, erect, dichotomously-branched rhizomes with rhizoids; branches exhibiting equal dichotomy are subordinate to a thicker sympodial main axis, which shows an unequal dichotomy; the stems are circinately coiled in the apical regions.

The stele consists of a large strand of tracheids which have both spiral and reticulate thickening, surrounded by protoxylem and phloem; the outer cortex of the aerial stem consists of four layers of thick-walled cells. Reniform appendages borne on special branches, which emerge from immediately below the bifurcation of the stems on the sympodial main axis, are interpreted as sporangia.

A peculiar organism resembling *Pachytheca* is described.

The Geology of the Snowdon Massif (North Wales). By HOWEL WILLIAMS, M.A., M.Sc., D.I.C., F.G.S.

The area described is limited on the north-east by the Pass of Llanberis, on the south-east by the Vale of Gwynant, on the south-west by the Colwyn and Gwyrfai Valleys to near the village of Salem, and on the north-west by the supposed line of junction between the Cambrian and the Ordovician rocks.

The general stratigraphical succession was shewn by the lecturer.

The exact relationship between the Ordovician and the Cambrian Systems on the northern flank of Snowdon is uncertain. The Ffestiniog Beds exposed on Moel Eilio are overlain, with only a very slight discordance of dip, by a group of tourmalinized sediments, tentatively regarded as the basal Arenig Grits. Above these grits is a thick series of grey and grey-green, apparently unfossiliferous, slates that bear a lithological resemblance to certain shales immediately above the basal ordovician grit in the Nantlle Valley and to the lowest Arenig rocks of Llanfrothen, Portmadoc.

The Llanvirn Beds are more than twice as thick as their equivalents in Anglesey, although only the top 400 or 500 feet are referable to the zone of *Didymograptus murchisoni.* The highest graptolitiferous horizon recognised on Snowdon is in the lower part of the zone of *Nemagraptus gracilis* (Llandeilo) and lies almost immediately beneath the earliest volcanic rocks on the mountain, the Talgau Lavas. It is separated from the Snowdon Volcanic Suite proper by a thick and persistent group of banded grits, carrying lava-flows that may perhaps belong to the same volcanic suite as the lavas of Capel Curig and Y Glyder Fach.

Ramsay's threefold division of the Snowdon Volcanic Suite remains the most useful basis for its study. The Upper and Lower Rhyolitis Series were derived from a potash-rich magma, not unlike that which furnished the " granitic " intrusions of Moel Perfedd, Bwlch-y-Cywion, and Mynydd Mawr. Support is thus lent to the view, expressed by Dr. A. Harker, that these intrusions may represent the sites of old volcanoes from which many of the Caernar-

vonshire lavas were erupted. The Beddded Pyroclastic Series is typically composed of green, well-banded pumice-tuffs of andesitic to basaltic character, and carries abundant bombs and lapilli of spilite and keratophyre. About Snowdon summit and elsewhere that series includes fossiliferous sediments of Lower Caradocian age, and is interbedded with potash-rhyolites and tuffs. The approximate age of the Snowdon Volcanic Suite is inferred to be between Middle Llandeilian (Zone of *Climacograptus peltifer*) and Middle Caradocian (Zone of *Dicranograptus clingani*).

Many dykes, inclined sheets, and bosses of quartz-porphyry, microgranophyre, and intrusive rhyolite occur on Snowdon, the greatest intrusion being that of Crib Goch, formerly considered to be an outlier of the Upper Rhyolitic Series. Both mineralogically and chemically, the acid intrusive rocks resemble the Snowdon rhyolites.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.

The following paper was read at the meeting held on December 14 ,1926 :—

A Contribution to the Study of the Origin of Petroleum. The erginisation of Fish Liver Oils and Other Bodies. By DR. W. R. ORMANDY, F.I.C., F.C.S., M.I.A.E., M.Inst.P.T., E. C CRAVEN, B.Sc., F.C.S., M.Inst.P.T., PROF. I. M. HEILBRON AND H J. CHANNON, B.A., M.Sc., A.I.C.

The first reference (1906) to a hydrocarbon in fish liver oils by Tsujimoto reported obtaining large quantities of the hydrocarbon from liver of *Squalus mitsukurii* and gave it the name squalene. The physical properties of the substance were described. Tsujimoto ascribed to it the formula $C_{30}H_{50}$. Meanwhile, Chapman reported that he had found in what was reputed to be a specimen of cod liver oil a large quantity of an unsaturated hydrocarbon. The oil had probably originated from the livers of *Centrophorus granulosus* and *Scymnorhinus lichia*, caught off the Moroccan coast. This hydrocarbon, spinacene, had similar properties to that described by Tsujimoto. The hydrocarbon was separated from the oil by distillation, was optically inactive and could be reduced to the saturated compound $C_{30}H_{62}$ which was, however, different from the normal hydrocarbon of that formula. Chapman concluded that the formula $C_{29}H_{48}$ was in better agreement with the analysis of a number of derivatives than was $C_{30}H_{50}$.

In 1920 Tsujimoto gave further results obtained in investigating liver oils from the sharks of Japanese waters. Squalene occurred in varying amounts in many of these. In some cases over 80 per cent. of the oil was squalene which occurred chiefly in the *Squalidæ* sharks.

It is unsaturated, containing six double bonds, b.p., 240-242° . at 2 mm.; density, 0.8596; refractive index 1.4972; iodine vaue, 377.6. It may be prepared from any of the oils in which it is present in quantity by saponifying the oil, extracting the unsaponifiable matter in the usual way, and purifying by distillation. It is preferable, however, to distil the liver oil directly, as was done by Tsuftimoto, and by Chapman. If the liver oil be distilled at low pressure, an almost colourless distillate is obtained, and the distillation may be carried on until the appearance of white fumes shows that the glycerides are decomposing. In this way most of the squalene may be obtained without the necessity of preliminary saponification of the liver oil. Traces of fatty acids with which the distillate is contaminated are removed by washing with alkali. Squalene hexahydrochloride is obtained by passing hydrochloric acid gas into a solution of sqnalene in acetone. The isolation of isomeric hydrochlorides indicates that squalene itself is a mixture of isomers. Heilbron, Kamm and Owens also report that another type of isomerisation of squalene is possible, for when treated with 95 per cent formic acid, squalene undergoes cyclisation.

Dry distillation of squalene and fractionation of the product yields not only members of the hemiterpene and monoterpene groups, but also sesquiterpenes and diterpenes and probably higher members of the same class. It is possible that squalene is a dihydrotriterpene, and one of the isomers may have the structure $C(CH_3)_2 = CH.CH_2.[(CH_2 C(CH_3) = CH.CH_2]_4CH_2.C(CH_3).CH(CH_3)$.

Berginisation of 400 g. was carried out in a 2-litre autoclave; reaction temperature, 470° .; initial hydrogen pressure 80 atmos. The pressure remained constant during the heating period, but on cooling, a fall to 63 atmos. was observed, considerable decomposition and hydrogenation having occurred.

The liguid product amounted to 75 per cent. of the sample used. On opening the autoclave a strong odour of benzine was observed.

There is a great resemblance between the behaviour of squalene and pinene under

berginisation conditions. It is, however, quite impossible to repeat the conditions so absolutely in these bomb experiments so as to make it worth while putting the results in parallel columns. There are considerable differences between the experiments on squalene, though every effort was made to work under the same conditions of time, temperature and pressure, but these differences are quantitative and not qualitative. It must be pointed out that certain classes of lignite when subjected to berginisation are also converted quantitatively into oil and gas, and that the oil so produced is in every way similar to the oil produced from squalene except that instead of traces of phenols 20 per cent. of phenols may be present. It has been found that the higher phenols, when subjected to suitable berginisation conditions, are converted into paraffins and lower phenols, and the lower the phenol the more soluble it is in water. If the conditions have ever existed which would convert fish liver oil into paraffin-like bodies, then similar conditions may have converted lignites into similar bodies, and the phenols being water soluble may have been washed away. It would appear from Bacon and Hamor that phenols have been found in a large number of petroleums. Engler also refers to the occurrence of phenols in several German oils. The whole subject is one of great interest, and further work with hydrogenation under pressure may lead to results of real value in this difficult problem of the origin of petroleum.

THE CARBON ATOM MODEL AND THE STRUCTURE OF THE DIAMOND.

By R. B. Lindsay (Yale University).

Using a method similar to one previously described by the writer the 2_1 orbits in neutral carbon are approximately computed, introducing the assumption that the four orbital planes are arranged in tetrahedral symmetry. The atoms are then distributed in the diamond lattice and the field on any electron due to its own atom and neighbonring atom is calculated as a function of the distance from the nucleus assuming that: (1) the orbital plane of the electron is oriented in a certain symmetrical way relative to the lines joining its nucleus to those of the neighbouring atoms; (2) for a first approximation only the four nearest atoms may be considered as effective; (3) the effect of the electrons in the neighbouring atoms is that due to a time distribution of their charges in their orbital planes, disregarding definite phase relations such as have been assumed by previous writers. An approximate expression for the increase in energy of the electron orbit due to the neighbouring atoms is developed, and the calculation of the lattice energy per electron for various values of a, the lattice constant, is carried out. The equilibrium value of a comes out between 1.10A and 1.60A (nearer the latter). In fact the heat of sublimation for a = 1.54A and Y = 168 to 177 calories per mol. Compressibility calculations for this model are being undertaken.—*Physical Review.*

NOTICES OF BOOKS.

An entirely new edition of *Gmelin's Treatise on Inorganic Chemistry* is apparently now ready. It is a complete and absolutely reliable reference book, comprising the entire field of inorganic chemistry. Its main object is to save the student the trouble of collecting the literature himself.

The work, which is a companion to the "Beilstein" of the organic chemist, was commenced by the Deutsche Chemische Gesellschaft in 1921. The basis for this comprehensive new work was furnished by Gmelin-Kraut's treatise. It was evident, however, that this work, whose seventh edition, began to appear in the year 1906, required re-arrangements, not only in its form but also in its conception, if it was to answer the requirements of the existing state of inorganic-chemical research. For this long lapse of time has not only produced a large number of new facts and data, but is also characterised by a new departure in research work on inorganic chemistry which must also be clearly defined in a modern treatise. These considerations coupled with the desire to arrange and classify the subject matter as clearly as possible and to subject it to critical treatment, led to an entire rearrangement of the seventh edition, so that the eighth must be considered an entirely new work.

The Anodic Oxidation of Aluminium and its Alloys as a Protection Against Corrosion.

During the years 1921-24 a series of investigations on methods of protecting aluminium and aluminium alloys against corrosion were carried out on behalf of the Department of Scientific and Industrial Research by the Corrosion Research Committee of the Institute of Metals. The principal outcome of the investigations was the development of a method of protecting

aluminium or its alloys by producing a strongly adherent film on the metallic surface by anodic oxidation. A second discovery of some interest and technical importance was that the aluminium so treated could be successfully dyed.

The laboratory investigations were followed up by successful experiments on a larger scale at the Royal Aircraft Establishment, Farnborough, by arrangement with the Air Ministry; and the process, which is protected by patent, is no being worked in this country by several firms under non-exclusive licences from the Department.

The results, which are interesting, are published in a 40-page pamphlet under authority of His Majesty's Stationery Office, at which copies may be purchased, price, 1s. 3d.

It is shewn that aluminium is fairly resistant to corrosion, due to a protective very thin film of aluminium oxide or hydroxide, which always exists on the surface of aluminium that has been exposed to the air. It is so thin as to be invisible. It is obvious that the destruction or rupture of this film is precedent to corrosion. It has been found that the cracking of the film is more likely to follow alternate wetting and drying of the metal than when it is kept totally immersed in a similar chloride solution. It is therefore suggested that the powers of aluminium to resist corrosion might be greatly increased if a strong and highly adherent film of oxide or hydroxide were formed on the metal in place of the thin natural film. The experiments of the authors show that the film produced by anodic oxidation in a bath containing a chromate, bichromate, or—best of all—chromic acid, protects the metal much more effectively against corrosion. The authors give a general description of the process, explain the chemical and physical nature of the film, the treatment of recesses, poses, etc., optimum conditions of treatment, etc.

The following conclusions are arrived at and the attached precautions suggested :—

(1) The anodic process for the treatment of aluminium and duralumin has been shown to be a process which may be worked on an industrial scale.

(2) The treatment of aluminium casting alloys is possible only in certain cases, and in other cases the process in its present state of development is inapplicable.

(3) Aluminium and duralumin may be rendered much more resistant to corrosion by this process. Treatment with lanoline after anodic oxidation improves the protection afforded.

(4) The mechanical properties of aluminium and duralumin are not influenced appreciably by anodic treatment, with the possible exception of those relating to bending.

Medical Precautions in Anodic Treatment.

It has been observed that workers with salts of chromium are exposed to a risk of erosion of the skin, and this question has been examined with special regard to the anodic treatment by the Medical Officer in charge at Royal Aaicraft Establishment.

The risk to workers appears to arise in this process from two possible sources.

1. Immersion of the hands in the bath of chromic acid. (There is little doubt that exposure of the skin to chromic acid of the strength indicated, for some considerable time, would result in irritation and probably in ulceration.)

2. The formation of "electrolytic spray." The objects treated in the Royal Aircraft Establishment have mostly been small; the current density is not great and there does not appear to be any serious risk of injury to health from this source. Under different workings conditions it is possible that this "spray" might give rise to irritation of the nasal mucous membrant and means might have to be devised to deal with it.

The following precautions were therefore recommended :—

1. Rubber gloves should be worn by the workers.

2. The level of the chromic acid solution should be kept down several inches below the top of the tank, and "spray" forming will then tend to be stopped by the tank sides and not pass into the room.

3. It may be found necessary when treating objects of large surface and using currents of greater density to cover over the tank with some form of hood, and even arrange for exhausting the contaminated air from the surface of the tank.

The workers at the Royal Aircraft Establishment are being kept under medical observation.

The current number of *Chemical Reviews* (Vol. III., No. 3.) for October, contains three interesting contributions :— Homogeneous Reactions, by C. N. Hinshelwood, Directive Influence in the Benzene Ring, by A. W. Francis, and Phenol Tests, A Classification of the Tests and a Review of the

Literature, by H. D. GIBBS. In all of them *the authors give a general account of the* subject, together with their own contributions to their respective fields of research.

The one by H. D. Gibbs on phenol tests is accompanied by a critical study of alternative tests for these substances, and contains a lengthy bibliography which should prove useful to organic chemists.

Chemical Reviews is published by the American Chemical Society, the London agents are *Messrs. Ballière, Tindall & Cox*, 8, Henrietta Street, London, W.C.2., and the subscription price is 22s. 6d. per annum for Great Britain.

WHITAKER'S ALMANACK.

12, Warwick Lane, London, E.C.

"Whitaker"! Everyone knows "Whitaker," and should there be any individual so benighted as not to know it, he would be ashamed to confess his ignorance. There are now two "Whitakers": one the complete edition (6s.), and one an abridged edition (1s. 6d.), which is an abridgement of the whole of the complete work. Both were published on the 10th inst., and are *sure to be much sought after as compact* reliable and varied reference books.

The 59th Annual Volume, which must henceforth be known as "The Complete Whitaker" (to distinguish it from the newly established Abridged Edition), has been almost entirely re-arranged, and the "Subscriber for many years" may feel puzzled, at first, in handling the new issue. The Editor hopes, however, that an examination of the Table of Contents will justify the re-arrangement under which the sections are now presented, and he feels that the references and cross-references contained in the Index will enable even the most impatient of inquirers to obtain the information required with the minimum of delay.

At the request of many readers a Table of "Abbreviations in Common Use" now follows the Index; and among the items of general interest will be found the results of the 1926 Census of Northern Ireland, the Irish Free State, the Commonwealth of Australia, the Dominion of New Zealand, and the Union of South Africa. The Editor has also been favoured with an article concerning New Zealand by the Prime Minister of the Dominion. Questions of the Day are dealt with in 57 short articles, and these are followed by Annual Summaries of Events, notable Deaths, Wills proved during the past twelve months, Meteorology for the year, Science and Invention, Art, Music, the Drama and a Retrospect of Sport, with a Diary of Events in the ensuing year. Among the summaries is a new article giving details of the meteorological conditions in the Harvest and Holiday months for the past 51 years.

As regards the Abridged Edition, the Table of Contents shews that the compression of sections formerly given at length has made possible the inclusion for the first time of many subjects of general interest hitherto reserved for the larger book. Among these new sections will be found an alphabetical series of 57 articles entitled "Questions of the Day," a fifty-one years' retrospect of "Holiday Weather," articles on "Science and Invention," "Art" and "Music," and a "Dramatic Summary" for the past year.

FARMING IN SOUTH AFRICA.

This useful publication is issued monthly in English and Afrikaans, price 5s. in South Africa, and 6s. foreign. Subscriptions to be sent to the Government Printer, Pretoria.

While the resources of the Government are used in providing, through this valuable publication, helpful advice and information for farmers and fruit growers, there is also given articles, contributions, and letters of interest to a much wider circle of persons. The Government of South Africa is to be congratulated on this and other practical evidence of true solicitude for the welfare of its inhabitants.

Practical Organic Chemistry for Students of Pharmacy and Medicine. By A. VINCE HOPPER, Ph.D., A.R.C.S.I., F.I.C., AND WILLIAM M. CUMMING, D.Sc., F.I.C. (Lecturer on Organic Chemistry, The Royal Technical College, Glasgow). Pp. XII. + 116. Price 4s. London: Messrs. Blackie & Son, Ltd., 50, Old Bailey, London.

Multum in Parvo describes this work, which has been written by practical scientific men, primarily for pharmacy students taking the chemist and druggist qualifying examination of the Pharmaceutical Society. The authors have purposely included matter not necessary for the class of students named, but this is a special advantage as affording any of those students an opportunity of "taking a broader outlook on the subject of organic chemistry." The enlargement of the book as noted will also render it useful for other students wishing to gain some practical knowledge of organic chemistry.

Miller's Experiments and the Constitution of Matter.

This is the title of an interesting pamphlet, originally published in Dutch, by Dr. W. Tombrock. It will be recalled that the ether-drift experiments were initiated by Prof. Michelson, who subsequently had the collaboration of Prof. Morley. They have since been extended by Prof. Miller, to whom this pamphlet is dedicated.

The Lorentz-Fitzgerald contraction, which matter is supposed to undergo by its motion through the ether, is based on the results of these experiments, as is Einstein's Special Theory of Relativity.

The question is treated very fully and the objections raised are discussed with special reference to the deductions dependent upon the results.

The price of Dr. Tombrock's disquisition is not stated.

The South African Department of Agriculture has just published, price 9d., a *Bulletin (No. 50)*, entitled, "Some Physical and Chemical Changes Occuring During the Ripening of Grapes," by P. R. V. R. Copeman, B.A., B.Sc., and G. Frater, B.A. It occupies 54 pages and contains the results of careful and systematic analyses and experiments extending over a period of some months during which the changes occurring in the grapes were studied.

The December issue of the *Fuel Economist*, price 2s. 6d., is a special one. Sir Alfred Mond's presidential address to the Institution of Fuel Technology occupies 10 pages and there are contributions from other specialists on "Modern Gas Manufacure Practice," "Combustion of Carbon," "The Occurrence, Working and Treatment of Brown Coal" (by Sir Richard Redmayne), "Smoke and Public Health" etc. There is also an important and topical supplement on the chemical industries of the Empire.

Messrs. William Geipel, of the Vulcan Works, St. Thomas Street, S.E.1., have sent us an informative catalogue of splices and tapes for rubber insulated wires. The importance of a perfect splice, the essentials of a good tape, and how to proceed, are clearly indicated. Our readers can obtain a copy gratis upon application.

FORTHCOMING EVENTS.

THE ROYAL INSTITUTION OF GREAT BRITAIN.

Juvenile Christmas Lectures, (101st Course) by Professor A. . Hill, on "Nerves and Muscles: How We Feel and Move: Tuesday, January 4: "The Lungs and Blood" (IV.); Thursday, January 6: "Nerves and Muscles Working Together" (V.); Saturday, January 8: "Speed, Strength and Endurance" (VI.).

THE INSTITUTION OF ELECTRICAL ENGINEERS.

Thursday, January 6, 1927.—Ordinary meeting in the Lecture Theatre of the Institution, at 6 p.m.—"*Electrical Equipment* of Track on the Underground Railways of London," By A. R. Cooper (Member).

Wireless Section Meeting.

Wednesday, January 5, 1927, at 6 p.m.—An informal discussion will take place on "The Acoustic Problems of Microphones and Loud-speakers." The subject will be introduced by Mr. G. H. Nash, C.B.E.

New Patents.

These particulars of New Patents of interest to Readers have been selected from the Official Journal of Patents, and are published by special permission of the Controller of His Majesty's Stationery Office.

Latest Patent Applications.

31,021.—British Dyestuffs Corporation, Ltd.—Azo dyestuffs. December 7th.

30,872.—Fabrique de produits Chimiques Rohner Soc. Anon. Pratteln.—Mannfacture of dyestuffs. December 6th.

30,992.—Soc. of Chemical Industry in Basle.—Manufacture of dyestuffs. December 7th.

Specifications Published.

251,229.—Soc. Chimique Des Usines du Rhone.—Process of manufacture of phosphoric esters of carbohydrates and polyvalent alcohols.

262,243.—British Dyestuffs Corporation, Ltd., Mendoza, M., and Saunders, K. H.—Azo dyestuffs.

246,156.—Soc. of Chemical Industry in Basle.—Manufacture of new thio-indoxyl derivatives.

255,466.—Chemische Fabrik auf Actien (Vorm E. Schering).—Process for the manufacture of new diacyliso-thiourea-S-alkylethers.

Abstract Published.

259,930.—Oxidising organic compounds.—Silesia Verein Chemischer Fabriken, Ilda- und Marienhutte, near Saaruum, Germany.

Solutions of polythionic acids or their salts are employed as oxidising agents for organic compounds. In examples (1) a solution containing the reaction product from methylaniline and carbon disulphide and a base is oxidised by polythionate solution; the product is dimethyldiphenyl-thiuram disulphide (2) dimethyldithiocarbamic acid is oxidised to tetramethyl-thiuram disulphide by means of sodium tetrathionate.

The Latest TRADE MARKS

This list of Trade Marks of interest to Readers has been selected from the Official Trade Marks Journal, and is Published by permission of the Controller of His Majesty's Stationery Office.

474,650.—Illustration of 2 triangles with the words COMCAR three times for calcium carbide. — Charles Henry Bingham, Junior, 34, Victoria Street, London, S.W.1. December 15th.

474,584.—Illustration of Gondola with a man attendant and the rising sun behind it, with the words GONDOLA BRAND for chemical substances prepared for use in medicine and pharmacy, but not including medicated soap, and not including any goods of a like kind to medicated soap.—Naamlooze Vennootschap Handel-Maatschappij Voorbeen J. F. Sick & Co., Leeuvehaven 153b, Rotterdam, Holland. December 15th.

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